



Spur and Helical Gears up to 78" Diameter.
Double Helical Gears up to 52" Diameter.
Bevel Gears up to 60" Diameter.
Worm Gears up to 24" centres.

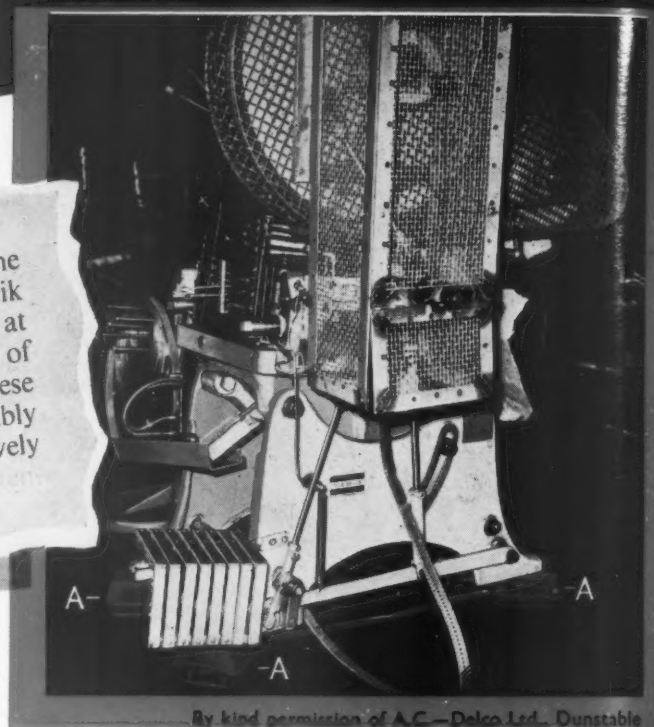
GEORGE ANGUS & CO LTD

Angus
GEARS

and an interesting feature of the installation is the provision of Metalastik 'A' Cushyfoot anti-vibration mountings as seen at 'A'. Compared with the conventional practice of bolting the presses directly to the floor, these mountings have resulted in a considerably longer life between regrinds of the relatively costly follow-on tools which are used.

from: "MACHINERY"

May 6, 1955



By kind permission of A.C.—Delco Ltd., Dunstable

Cushyfoot mountings on presses

The illustrations show three presses mounted on 'Cushyfoot' mountings, where they have been most successful in reducing noise and shock, thus bringing benefit not only to the operators but also to the rest of the staff and — sometimes — to neighbours. Moreover, as the cutting from 'Machinery' shows, press tools have been found to last longer between regrinds.

Metalastik experience is at your disposal in meeting any vibration problem, whether the motion is linear or rotary, and in providing oilless bearings for accommodating articulatory movement.

METALASTIK LTD., LEICESTER

METALASTIK

Incidental Invention

WHEN the National Research Development Corporation finds that half the inventions submitted for its consideration come from government departments and universities and half from private persons, and that of the first half about 50% are found to be acceptable for development while of the second half only one or two a year survive—when the corporation finds this relationship it is confirming industrial experience of the fruitfulness of the practical problem as compared with purely imaginative synthesis.

When in practical work, whether in the laboratory, the drawing office, the workshop or the factory there is presented a difficulty, a need or a disability, then some ingenuity has to be forthcoming to get things going again. This is always happening and is a major source of the flow of patent applications, not all of which are by any means concerned with inventions in the absolute sense of real discovery. The real invention has its germ in such happenings but usually it takes a good deal of work to develop to its true form. In the first place its basic simplicity must be discovered, and that may be quite a task, for the particular application in which it is first glimpsed is often surrounded by the complications of a special application. Having got to the basis of the invention, its true core, then it has to be expanded to its useful applications in order to make it patentable.

The actual figures of inventions submitted to the National Research Development Corporation are, of a total intake of some 600 a year, about 250 from government departments and the medical and agricultural research councils, 50 to 100 from the universities and 30 or so from Commonwealth official organizations and the industrial research associations. It is this lot which produces the 50% of successes already mentioned. The remaining 300 are from private inventors—and only one or two survive. In its latest report the corporation states that these private submissions receive the most careful consideration, and goes on to repeat the view expressed in an earlier report that experience has failed to confirm that a multiplicity of meritorious private inventors stand in need of public assistance.

The truth seems to be that successful invention stems from practical work. Edison, often regarded as a professional inventor, was really a scientific experimenter and his inventions grew out of his experiments. It certainly looks as though invention is not something to be sought, but something that will happen if perfection is striven after in some interest or branch of technology.

LOG SHEET

Large Impact Machine

The Admiralty has recently installed at the Naval Construction Research Establishment, Dunfermline, a large impact machine which is capable of delivering 500,000 ft/lb of energy to a test specimen. It will be used to study the behaviour, under high rates of loading, of the various steels and welded joints used in warship construction. Although the primary use of this machine will be in connection with research for application in the construction of warships, it is expected that much of the information to be obtained will be of a fundamental nature, of value not only in other branches of engineering but also to steelmakers.

Consultants for the project were Professor J. F. Baker, Mr. A. M. P. Brookes and Mr. J. L. Reddaway of Cambridge University; and, in early design studies, Viscount Caldecote was also engaged. The machine was manufactured by Fielding and Platt, Atlas Works, Gloucester.

Anechoic Chamber

As part of an intensive two-year research programme into the causes of transformer noise, the Distribution Transformer Department of Ferranti Limited, at West Gorton, Manchester, have recently completed a new anechoic chamber. The research programme is being undertaken as a result of the Electricity Board/BEAMA Sub-Committee proposals that manufacturers should take measurements of noise emitted from transformers with a view to the eventual specification of maximum sound levels for transformers ranging from 1000kVA to 100,000 kVA. Research work on noise from large power transformers has been proceeding at the company's Hollinwood factory for a number of years, but it was decided that independent investigations should be carried out on distribution transformers.

The double-walled brick chamber is located within the factory in the existing production line, so that, in testing procedures visualised for the future, the transformers having previously undergone routine tests would then pass through the chamber for noise level tests before being packed ready for despatch. The double brick wall construction



The completed anechoic chamber in the Distribution Transformer Department of Ferranti Limited at West Gorton, Manchester. As shown, the tracks conveying transformers to and from the chamber, are broken at the line of the door to make a soundproof seal.

ensures that no airborne noises are admitted.

Groundborne noises have also been taken into consideration and to prevent these affecting measurements taken inside the chamber, the inner shell of the chamber is built on a "floating" concrete base resting on a thick cork membrane. The chamber has been made sufficiently large so that anechoic wedges can be fitted if required.

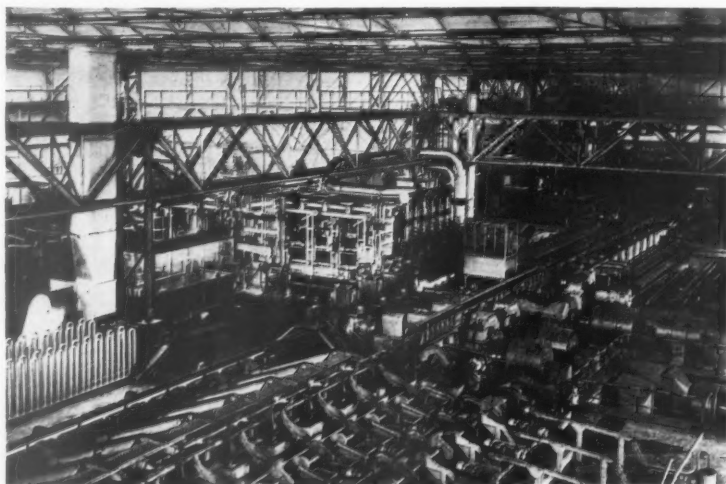
Provision has also been made for doors leading into and out of the chamber to have a filling of glass wool to act as an absorbent for sound, and the tracks conveying transformers to and from the chamber are broken at the line of the door in order to make a sound-proof seal. All noise measurements are taken in a central control office and the cable trench carrying power supply cables to transformers under test is filled with sound absorbent material.

Irradiated Cables for Rocket Research

A range of multi-core irradiated polythene cables has recently been supplied by British Insulated Callender's Cables Limited for use at the new rocket research establishment at Spadeadam, Cumberland. The cables were designed in co-operation with the Ministry of Works and Pye Limited, the latter being responsible for much of the instrumentation of the site.

The cables are in various sizes and consist of stranded conductors insulated with high density polythene, the cores being laid together, screened overall with braid and polythene over-sheathed. The completed cable is then passed continuously through an electron beam, the source of irradiation being provided by a 2,000,000-volt Van de Graaff electrostatic particle accelerator.

The cables are required to operate



ITALIAN SEAMLESS TUBE INSTALLATION.—This new continuous-process tube rolling mill has been made by Innocenti SG of Milan for Dalmine S.p.A. works at Costa Volpino, Italy. A second similar installation will be finished at another Dalmine plant in a few months time. When fully in production these installations will make "Pellegrino" (Italian for Pilgrim—the Continental term for the Pilger process) tubing of 60-175 mm dia and continuous tubing of 53-92 mm at a rate of 150,000 tons per year.

during short-term high temperature conditions and were specially developed for this purpose. It is the first time that the manufacture of this type of cable has been carried out in Great Britain.

Cables for St. Lawrence Project

A great electrical power development is in progress on the St. Lawrence river. In September 1958 the first stages were completed and energized covering Ontario, New York State and Vermont.

On this project, BICC 230,000-volt single-core oil-filled cables manufactured at Erith, Kent, have been used for the transmission of electrical energy from the Robert H. Saunders—St. Lawrence Generating Station on the Canadian side. They will carry the entire 1,100,000 hp generated by the Canadian section of the project.

The power will be supplied from sixteen generators. Four 3-phase circuits are being installed from the generator transformer units to sealing ends on the north side of the tail-race, the cables running through two tunnels which are an integral part of the dam. Each cable circuit will carry the output of four 13,800 volt, 60,000 kVA (95% P.F.) generators.

The four circuits comprise some 20,000 ft of single-core 230,000 volt, 960 MCM (0.75 square inch) copper conductor, lead sheathed, tin bronze reinforced oil-filled cables. These are just under 4 in. dia and weigh approximately 14 lb per ft. Anti-corrosive protection is obtained by means of layers of P.V.C. and rubber tapes with fireproof hessian and cotton tapes overall. The cable lengths vary from 900 ft to more than 2,200 ft, the longest with its drum weighing over 20 tons.

Provision has been made for the mechanical stresses set up by thermal expansion in heavy single conductor cables, and the cleating arrangements are such that the effects of expansion will be evenly distributed throughout the cable length. This is achieved by pre-setting the cable into a symmetrical wave form with fixed and sliding cleats spaced to ensure that each expansion loop takes its correct share of the total movement.

Each cable route includes a right-



MAINTENANCE CRADLE.—This maintenance cradle is suspended from rails which allow it to be moved as required under the roof. It is permanently installed at the premises of Tanqueray Gordon & Co. Limited, distillers, London, and is 46 ft long, 3 ft deep and 5 ft wide. It was designed and erected by Dexion Limited in five man-days, to fit existing bogie framework, and cost £120

angle bend at each end where the cable terminates in a sealing end and one 45° each way at an offset in the tunnel. A novel pulling-in technique has been evolved by which the cable is practically carried into its final position by means of a suspended steel hawser passed through sheaves. Power is obtained from a gas-driven winch with a 100 hp motor, the line tension being continuously measured by a dynamometer.

Perkins Gas Turbine

F. Perkins Limited are to manufacture a range of industrial gas turbines from 50–1500 hp designed and developed by the Solar Aircraft Company, of San Diego, California, the Peterborough company having acquired the whole of the share capital of Sugg-Solar Limited, of Westminster, which formerly had a licence from Solar to manufacture the Mars gas turbine: the name has been changed to Perkins Gas Turbines Limited.

It is the intention of Perkins initially to manufacture the Solar gas turbines in the 50–200 hp range and to market the 500 hp Jupiter engine and the new 1250 Saturn from current production at San Diego. Manufacture of the 50 hp Mars engine has already started at Peter-

borough. More than 2500 Mars gas turbines, which weigh only 98 lb with standard gearbox and all controls, have now been built by the U.S. company. They have accumulated more than a million hours of operation in a variety of applications. These include portable pumps for fire-fighting and industrial purposes, generating sets, compressors, smoke generators, shipboard de-icing equipment and others.

Oil Drilling Towers

A number of large towers are to be erected on the sea bed in the Persian Gulf by a British oil company to drill oil from beneath the sea and convey it by pipe line to a refinery on the mainland. The British Industrial Engineering Company Limited are making two of these towers, each of which will contain about 230 tons of steel. The towers will have landing stages for workmen, an operating deck, with a landing deck for helicopters at the top of the structure. One section which went off recently to the Middle East is 56 ft 6 in. long, 20 ft 6 in. wide, 12 ft 6 in. high and weighs 35 tons. The makers have completed two of these sections which together will form the lower part of one tower. The sections are believed to be the largest all welded tubular structures yet fabricated in the Midlands.

Slurry Pumps for Tunnelling

The engineers and miners working from each side of the river have linked-up and another stage in the work on the Purfleet-Dartford tunnel connecting Kent and Essex, which should be completed and the tunnel available for traffic in 1962, has been reached. One factor which contributed to the speed of the work was that the excavated material was crushed, mixed with water and pumped to the surface as slurry. It is believed that this is the first time this system has been used in tunnel boring where the working face has been maintained constantly at a pressure of 20-30 psi.

Two 300-ton, 30-ft. dia cutting shields were worked away from the 80-ft shafts, on each side of the river, where they were erected before 1939. Work on the tunnel stopped during the war but since operations recommenced, over 3300 ft out of 4688 ft of tunnel length has been excavated.

The shields trimmed inside of the excavation and as they moved forward cast iron rings were built-in behind to form the 28 ft dia tunnel lining. The excavated material, chalk and flint, was picked up behind the shield and loaded on to shaker conveyors which fed the crushing plant. After mixing with water the slurry was pumped to the surface 110 ft above. The slurry was deposited on the surface in lagoons approximately 1000 ft away from the working shafts, the solid material obtained being used for the building of flood banks, etc.

The pumps, supplied by Gwynnes Pumps Limited, were of the centrifugal type having steel casings and impellers, the impellers being of the open vane self-clearing type capable of passing solids in the form of spheres up to approximately 1 in. dia. The pumps were direct coupled to 30 hp totally enclosed fan-cooled Crompton Parkinson squirrel cage motors, a hydraulic coupling being interposed on some of the units. This allowed for speed variation to compensate for the head against which the units were pumping as the pipeline lengthened in the course of excavation.

Edmond Nuttall Sons & Co. (London) Limited are the contractors for the work which is being carried out for the Dartford Tunnel Committee of the Kent and Essex County Councils and the Ministry of Transport and Civil Aviation, the

consulting engineers being Messrs. Mott, Hay & Anderson and Messrs. Coode & Partners.



TRUCKS WITH ELEVATING ALUMINIUM BODIES.—The lightness of aluminium is of great importance in a new range of vans and trucks designed by Rootes Motors Limited. The new "Cargo Lift" range is primarily for aircraft loading and servicing. The vehicles have a conventional four-wheeled chassis and cab, but the body is attached by pairs of scissor linkages lifted by two hydraulic rams. The body builders, Wildson and Co. Limited, of Solihull, used Noral B51SWP aluminium alloy top-hat extruded sections in the construction of the van. The truck body also has a Noral B51SWP framework and is panelled in Noral B51SWP sheet supplied by Northern Aluminium Company Limited.

Track Recording Coach

The new British Railways track recording coach can pinpoint and record the smallest of irregularities in rail track, and will be an aid in making better use of manpower and materials for track maintenance. By a system of electrical measurements the coach verifies and records on a moving chart the width between rails (the gauge), the regularity of track curvature, and, by relating axle movement to a high-speed gyroscope, whether curved lines are banked to exactly the right angle for express speeds. An important feature is that the measurements are taken at speeds of up to 30 mph, the track bearing the load of the 24-ton vehicle as it moves along.

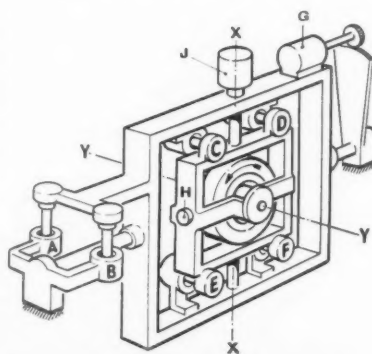
The coach was designed and developed by Elliott Brothers (London) Limited.

Measuring Equipment

For the measurement of gauge and curvature, the probes are carried from a lattice girder framework supported at the axle boxes. So that the axles may follow the track without restraint, the points of support of this framework are arranged to give the necessary degrees of freedom permitting the axles to twist relatively in both vertical and lateral planes. In addition, "break-out" springs limit the shock which the framework receives when the wheels are sub-

jected to severe vertical accelerations. The sensing probes are spring loaded against the rails and special guide shoes, running in the opposite flange way, ensure their passage through gaps at points and other fittings. At the actual opening in a crossing this guide shoe comes against the opposite check rail and prevents the sensing shoe from taking the wrong route. Due to its small size the probe is an extremely sensitive detecting element of low inertia giving immediate and accurate response to any deviation from line or gauge. (This patented Elliott system obviates the need for a long probe otherwise required to span the gaps at points and crossings.)

When operating, the probes are held down by compressed air and can be withdrawn clear of the track, when not in use. Raising and lowering is controlled through solenoid operated valves. There is also a special emergency switch which enables the probes to be retracted by the observer if obstructions are seen on the track. Without stopping the vehicle, the probes can be lowered



Horizontal gyroscopic datum for cant measurement in track recording coach. A and B, torque motors to keep spin axis, Y-Y, across the vehicle. C and D, torque motors to compensate for centrifugal force on offset weight H. E and F, torque motors to correct for earth's rotation effect in plane of cant measurement. G, pick off for angle between floor and spin axis Y-Y; (angle between floor and axle added electrically). H, offset weight which precesses gyro until axis X-X is vertical. J, A, C, pick off to operate torque motors A and B.

again on any piece of straight or curved track clear of points or other track fittings. The rubbing face of the probe consists of a welded deposit which can be renewed when required. At present the vehicle incorporates provision for measurement of curvature on one rail only. Irregularities on the other rail are deduced from the gauge record. Additional equipment to measure curvature on both rails can be easily added.

Cant is measured by comparing the position of one of the axles with

a datum provided by a gyroscope mounted immediately above this axle. The spin axis of the gyroscope is maintained horizontal across the coach at all times. Correcting torques are applied to balance the effect of the earth's rotation and to allow for the movement of the vehicle around curves. The use of a gyroscope avoids the significant errors which can occur if a pendulum is used as a datum.

Measurements of curvature, gauge and cant are obtained as a.c. signals from synchro type pick-offs. These signals are linearly demodulated and the resulting d.c. signals applied to high - sensitivity mirror galvanometers. The record is produced by these galvanometers on a special photographic paper by the reflected beams of an ultra-violet light source.

In addition to the main measurements, the record includes the speed of the vehicle, distance marking, facilities to indicate events such as stations and space for making notes. The new record together with the "play-back" of a previous record are both fed through the recorder by a drive taken from one of the axle-boxes; a choice of scales is provided.

The Coach Vehicle

The coach was sub-contracted by Elliott Brothers (London) Limited to D. Wickham & Co. Limited of Ware, the rail car manufacturers. It is a self-propelled 4-wheeled vehicle similar to the rail buses already in operation in several regions of the British Railways system. There is a driver's and observer's position at each end. Propulsion is by a Meadows horizontal under-floor diesel engine developing 97 bhp, driving through a centrifugal clutch and epicyclic gear box to the forward and reverse gear box mounted on the driving axle. Gear changing is by electro-pneumatic valves; compressed air and hand brakes operate on the driving axle. Wheels and axles are carried in Timken double tapered roller bearings. The axle boxes are secured to the frame by radius rods and the suspension is by overslung laminated springs carried in hangers fitted with rubber sandwich inserts. To improve the accuracy of cant measurement the wheels are coned to a taper of 1 in 100.

As an adequate axle load was needed to detect voids under sleepers, the weight of the vehicle posed no special design problems and the frame is therefore of substantial fabricated construction with con-

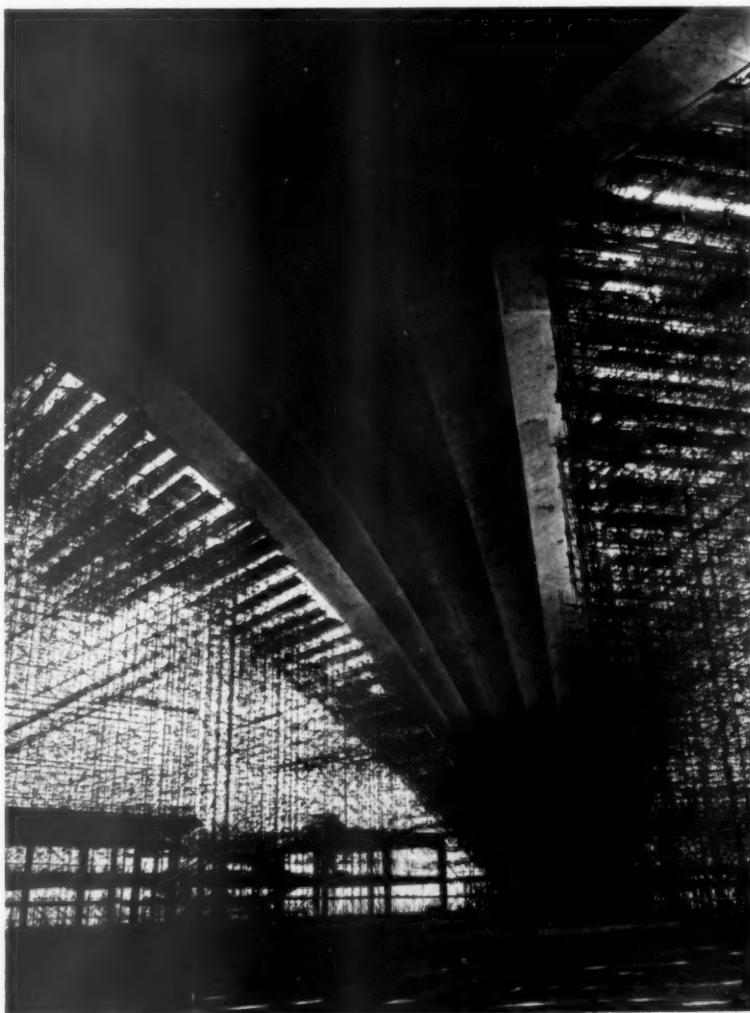
ventional buffing and draw gear. The body is mounted directly on to the frame. This is also of fabricated construction, panelled inside and outside, and double doors are fitted on each side near the centre of the vehicle.

The main electrical supplies are provided by an Enfield diesel generator of 5 kW capacity at 230 volts d.c. From this output a Vernons alternator gives the 400 cps supplies for the gyroscopes and synchros.

TRIATIC ARCH.—Unique design features and constructional methods are to be found in the new exhibition hall being built in Paris. Constructed entirely in reinforced and pre-stressed and post-tensioned concrete, the roof is a thin shelled dome with apexes at ground level resting on three massive prismatic abutments. With an area of 237,000 sq ft the hall is an equilateral triangle of 738 ft side. The crown of the roof where the three spans meet is 157 ft high. To compact the special dry concrete mixes used in the roof construction a high frequency low amplitude vibrator was developed by Vibratechniques of Paris. Known as Sinex, this new vibrator is marketed in the U.K. and the Commonwealth (except Canada) by Holmann Brothers Limited, Camborne, Cornwall

Largest Rolling Mill Power Unit

The new four-stand tandem cold strip mill recently commissioned at the Abbey Works of The Steel Company of Wales has the largest electrical power unit of any cold rolling mill in Britain. The electrical drive, supplied by Associated Electrical Industries, Heavy Plant Division, includes motors totalling 19,750 hp, which drive the four stands and the reel. These motors are fed by two synchronous motor-generator sets in each of which the driving motor is rated at 11,600 hp. There is no separate motor-room, all the main machines being totally enclosed and mounted in the mill area. Control and excitation of the machines are mainly static, using A.E.I. Magnestats (magnetic amplifiers).



Materials Handling in Industry

The efficiency of handling is measured by the ratio of processing time to the sum of the times of processing and handling. The objective of good materials handling is to reduce the denominator in this expression: this leads to lower production cost, less handling time, increased production capacity, and improved safety

By W. A. WOEBER, D.Sc., M.I.Mech.E.

THE handling of materials has always been a challenge to man's ingenuity. The necessity to lift and to move heavy objects resulted in the invention of the lever and the wheel. Handling implements found in prehistoric graves are often well constructed and imply no little mechanical experience in their use. Inscriptions on Egyptian and Assyrian monuments frequently depict contrivances especially fashioned for the handling of materials (Fig. 1).

In spite of the rough and simple expedients employed, some of the handling feats of the ancients would present an exacting test for the most modern of materials handling equipment. The effort expended on such works as the erection of the Great Pyramid at Gizeh (3733–3566 B.C.), for instance, must have been enormous. Huge blocks of stone, many of which measure 20 ft by 6 ft square, had to be quarried and transported over long distances. It has been suggested that these blocks were raised into position by means of rockers of the type illustrated in Fig. 2.

Thus, from the days of antiquity, man's efforts and ingenuity have continuously been concentrated on the handling of materials and their transport over long distances.

The term 'Materials Handling' as it is understood today, refers however to the movement of materials over relatively short distances within an industrial establishment. It may be defined as the rational approach to the short-range transportation of raw materials and tools, materials in process and finished products, and it also includes the removal of waste products.

When the materials handling function is carried out by the use of mechanized equipment, the more restrictive term 'Mechanical Handling' is applied.

Interprocess and storage handling

The definition of 'Materials Handling' limits its function to the movement of materials within an indus-

* Opening lecture at the South African Materials Handling Conference held in Johannesburg under the auspices of the South African Institution of Mechanical Engineers. (South African Institution of Engineers Journal.)

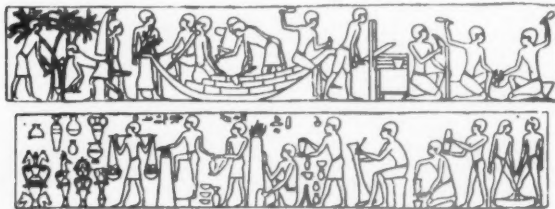


Fig. 1.—The great antiquity of the subject of materials handling is indicated by inscriptions on ancient Egyptian and Assyrian monuments, which frequently depict handling contrivances

trial establishment since the movement outside these boundaries is generally considered under the heading of 'transportation'.

The handling function within an industrial establishment comprises:—

- (a) *Process handling*—which may be looked upon as an integral part of the operation itself
- (b) *Interprocess handling*—which is concerned with the movement of materials from one stage of the process operation to another
- (c) *Storage handling*—which is the handling of materials into and out of storage during their passage along the production line.

The methods and techniques employed for interprocess and storage handling are entirely at the discretion of the factory management and the problems involved are common to all industries. The process handling methods are however dependent upon the design and the operation of the processing plant and equipment.

Since the interprocess and storage handling functions are not directly associated with the manufacturing process, they are frequently accepted without question. Symptoms of poor handling and high costs are often obscured by familiarity and therefore not easily recognized.

The effect of inefficient handling may be further concealed by an inadequate system of control. Any attempt at improving the position therefore requires the adoption of a co-ordinated and systematic approach by investigators who understand the handling problem and who are able to detect the symptoms of poor handling.

Industry is concerned with the process of converting raw materials into finished products by means of a series of production operations. With the continual change of materials and products and the development of new processes and equipment, new operational problems are created which in turn demand periodical reviews of current handling methods.

It is quite evident, therefore, that considerable scope exists in any type of modern industry for improvement



Fig. 2.—Rockers like this may have been used to handle the great stones used in the building of the pyramids

and economy in the methods of materials handling and in particular in interprocess and storage handling.

Handling efficiency

Whilst considerable attention is being paid in industry to the improvement of the manufacturing processes, the ancillary activities entailed in the handling and storage of materials are frequently considered to be of secondary importance.

It is not possible to divorce the actual manufacturing process from the handling operations since an efficient production system requires the successful integration of modern materials handling techniques with the whole production cycle.

Production efficiency is sometimes expressed as the ratio of the actual processing time to the time that has elapsed between the receipt of raw materials and the despatch of finished products:

$$\text{Production efficiency} = \frac{\text{Actual processing time}}{\text{Elapsed time in plant}}$$

The total elapsed time includes all processing and handling time and the periods lost in waiting and storing. It is felt, however, that production efficiency, as defined above, has little practical significance and that a comparison of the total handling time with the actual processing time will be of greater practical value:

$$\text{Handling efficiency} = \frac{\text{Actual processing time}}{\text{Processing plus handling times}}$$

It should be pointed out that as process handling forms an integral part of the manufacturing operation, process handling time is excluded from the denominator in the expression for handling efficiency.

An indication of the handling efficiency coupled with a statement of the handling costs per unit output of product would, in the author's view, present a proper criterion of the efficacy of a materials handling system.

The concept of handling efficiency will be made clear by a reference to the superphosphate manufacturing process with which the author has been associated for some time:

Example.—Manufacture of 100 tons of granulated and bagged chemical fertilizer 5—13—5 ($\text{N}_2\text{—P}_2\text{O}_5\text{—K}_2\text{O}$).

| Stages of production | Time in minutes | |
|--|-----------------|----------|
| | Process- ing | Handling |
| 1. Handling into storage: | | |
| 40 t phosphate rock ... | | 45 |
| 24 t ammonium sulphate ... | | 30 |
| 8 t muriate of potash ... | | 10 |
| 1 t filler ... | | 10 |
| 2. Pump to process: | | |
| 27 t sulphuric acid (78%) | | 25 |
| 3. Transport 2000 paper bags to empty bag store ... | | 60 |
| 4. Reclaim 40 t rock and feed to mill bunkers ... | | 20 |
| 5. Mill 40 t phosphate rock ... | 80 | |
| 6. Feed milled rock to acidulating plant ... | | 80 |
| 7. Acidulate rock to produce 67 t 19.5% c/s superphosphate ... | 80 | |

| | | |
|---|-----|------|
| 8. Handle superphosphate into maturing store ... | | 80 |
| 9. Reclaim from storage and deliver to mixing plant: | | |
| 67 t superphosphate ... | | 30 |
| 24 t ammonium sulphate ... | | 10 |
| 8 t muriate of potash ... | | 7 |
| 1 t filler ... | | 3 |
| 10. Screen and mix ingredients... | 300 | |
| 11. Transport mixture into granulation plant ... | | 300 |
| 12. Granulate, dry and cool mixture ... | 300 | |
| 13. Transport granular mixture to store ... | | 300 |
| 14. Transfer mixture from granules store to bagging plant | | 100 |
| 15. Transport empty bags, etc. to bagging plant ... | | 30 |
| 16. Dress, weigh and bag material ... | 100 | |
| 17. Load 2000 × 100 lb bags into truck ... | | 100 |
| Total ... | 860 | 1240 |

The handling efficiency at the above plant is therefore $(860/2100) \times 100 = 41\%$ (say) and may be used for the purpose of comparison with that of similar plants manufacturing the same product in equal units.

Handling principles

The main objective of good materials handling is to reduce the denominator in the expression for handling efficiency. This main objective is fourfold, namely (a) to lower production cost, (b) to reduce handling time, (c) to increase production capacity and (d) to improve safety.

(a) In order to *lower the costs* of production the non-productive handling activities must be reduced to a practical minimum. It will be well, therefore, to head the list of materials handling principles by the well-known axiom:

"Every time a material is handled something is added to its cost and nothing to its value". The corollaries to this principle are:

- (1) minimise handling of all kinds, since it adds nothing but cost to the finished product
- (2) mechanize handling wherever economical
- (3) make use of gravity wherever possible.

(b) In order to *reduce handling time* it is necessary to

- (4) avoid re-handling
- (5) use equipment that sets a uniform pace
- (6) handle large lots in unit loads.

(c) The specific objective of *increasing the capacity of a plant* or a machine, or raising the production per unit of plant area, is attained by:

- (7) integrating materials handling with the process
- (8) correlating materials handling with production schedules
- (9) planning handling systems in relation to plant layout and vice versa
- (10) keeping stocks at minima consistent with production requirements.

(d) The last objective, that of *improving safety*, has to be viewed not only from the humanitarian aspect but also in the light of improving the quality of a product by reducing damage to materials and parts.



Fig. 3. (above) and Fig. 4 (right) contrast old and new methods of handling large quantities of bags. The fork-lift truck saves much labour and the time of road vehicles and stocktakers

Carefully planned handling techniques will render many industrial functions less fatiguing and less dangerous and well designed handling equipment will prevent breakage and spillage.

Handling surveys

The problem of increasing the handling efficiency may face an industry at any time and some improvement can nearly always be achieved by employing better methods and techniques.

In order to assess correctly the efficiency of existing handling methods and to submit recommendations for their improvement it is necessary to carry out a materials handling survey.

The initiative must of course be taken by top management and the authority and responsibility for improving the situation must be placed with a person experienced in method study and, if at all possible, acquainted with the technology of the production process involved.

- The survey must begin with the factual recording of
- what is done, and
 - what is proposed to be done.

This entails a thorough investigation of all operations and movements and requires the preparation of a scale drawing of the existing plant layout. The layout drawing must show where materials are received, stored, processed and despatched so that the movements of the raw materials, semi-processed goods and finished products can be traced from point to point. Circuitous routes, blockages and conditions which result in re-handling and waiting can then be detected.

The analysis is repeated in greater detail by tracing the path of a suitable component along the production line. A separate record is then made of the number of times it is handled, the distance it travels each time towards the production line, the number of men involved and the weight lifted by them. This record, when completed, forms what is known as a "flow chart". If the flow is delayed the position is noted, also whether skilled operators have to interrupt their productive work to carry out manual handling operations. The investigation is extended and carried out in every significant detail until a complete picture has been built up of the materials handling system throughout the plant. The "significant details" may well include particulars such as the condition and number of floor levels, the steepness of ramps,



the sizes of door openings, the height and strength of ceilings, walls and columns, and headroom clearances. Account is also taken of the size, weight, physical nature and rate of flow of the products to be handled and of the packaging and storage facilities. Scale models to test new routes or to suggest rearrangement of machines are frequently employed at this stage of the survey.

As in any method study, the data collected during the survey are subjected to systematic analysis and critical examination in the light of the materials handling principles discussed previously.

Having recognized unnecessary operations which may also include unnecessary inspections, samplings and check-weighings, the materials handling engineer will be able to plan the required alterations and improvements.

Such improvements may well be based on a complete alteration of the existing plant layout, or a judicious introduction of mechanical handling equipment; they may even require structural alterations to buildings and roadways.

Handling costs

Production costs are directly related to the indirect costs of manufacture. A large proportion of the latter is represented by the costs of materials handling which in turn are affected by:

- the method of handling of the work pieces by the operators at the processing machines and assembly benches
- the method of moving materials between processing operations, and
- the method adopted for warehousing and storing of the raw materials and semi-processed goods.

More efficient and economical handling in each of these three phases will result in a reduction of the total cost of production.



Fig. 5 (left) and Fig. 6 (right) contrast methods of handling boxes. Using a truck saved labour, increased the storage space and reduced accidents

The first step in the analysis of the indirect costs is therefore a review of existing handling methods with reference to the flow chart. From this chart the cost of handling time and labour can be estimated. A more detailed study will probably reveal one or more points along the production line where waste and labour costs are prohibitive and where a cost reduction from better handling can immediately be expected.

The next step entails the computation of the handling costs per unit output of product. The data thus obtained can be used effectively for budgetary control of handling operations and for the quick appraisal of new materials handling methods.

The report on the completed survey may well contain an economic justification for the installation of new mechanical handling equipment at a time when the need for some new direct processing plant also exists. When such a choice arises, it may be more economical to buy the handling equipment as the capital expenditure for such items can often be recovered in a shorter time than is normal with new processing plant.

In order to illustrate how the various factors introduced by better techniques and more suitable handling equipment are influencing costs and improving productivity generally, two case examples, taken from the activities of the organization with which the author is associated, will be cited.

Example.—Improved handling and storage of empty paper bags.

Approximately 6,000,000 pre-printed, multi-walled paper bags are received annually from suppliers who are eight miles by road from the plant. In view of the large number of different grades of fertilizer bagged, the plant has to store approximately one million bags during the peak seasons and the rate of usage may be anything up to 60,000 bags per day.

Old method (Fig. 3).—Bags were received by road and rail in bundles of 50. The quantity per rail truck averaged 80,000 bags. Ten natives offloaded and stacked the contents of one truck in approximately four hours. Three natives were employed full-time on delivering bags to the filling points. A total of at least six natives would have been required to deliver bags in bundles from the new store.

New method (Fig. 4).—Unit loads of 2000 bags are delivered by road transport in quantities up to 18,000 bags at a time. This number of bags is offloaded and stacked by one fork-lift truck within 30 minutes.

The same fork-lift truck can supply the total daily requirements of the filling points over a single shift.

Results:

- (1) Saving of five natives who would have been required to distribute bags to the filling points from the new store.
- (2) Saving of 2000 native-hours per year in offloading incoming rail trucks and stacking bundles
- (3) Quicker turn-round of road vehicles
- (4) Stock-taking considerably simplified
- (5) Return on capital invested, 35% p.a.

Example.—Improved handling and storage of boxes containing safety fuse.—Each year, on an average, 37,000 boxes of safety fuse weighing 250 lb each are received by rail from Durban Docks. On receipt the boxes have to be offloaded and stacked in store. Boxes are de-stacked and delivered to first process at an average rate of approximately 200 boxes per day.

Old method (Fig. 5).—Eight natives were needed to carry the boxes from the rail truck and stack them in the store. These boxes can only be stacked six high with safety. The same natives were employed to de-stack and handle boxes to first process.

New method (Fig. 6).—One native with a fork-lift truck which is fitted with a squeeze clamp can transport and stack the same number of boxes in composite unit loads of ten. He can safely stack these boxes ten high. The same native de-stacks and delivers unit loads to first process.

Results:

- (1) Elimination of seven natives previously employed for handling boxes through storage
- (2) Storage utilization increased by 66%
- (3) Reduction in handling accidents
- (4) A further annual saving of approximately 10,000 native hours can be achieved if the boxes are received in unit loads and suitably arranged for direct offloading by fork-lift trucks
- (5) Return on capital invested, 40% p.a.

Equipment policy

It is beyond the scope of this paper to describe in detail the range of mechanical handling equipment available. In the selection of new equipment due regard must be paid to:

- (a) Economic justification
- (b) Adaptability
- (c) Standardization
- (d) Maintenance.

The correct choice of handling equipment for each individual application depends on many factors. There are, however, general rules which, when used with discretion, can assist in the selection:

- (i) Use *conveyors* for the movement of materials in a straight or curved line between two or more fixed points
- (ii) Use *cranes and hoists* for the movement of materials in an area of fixed limits
- (iii) Use *trucks and tractors* for the movement of materials between a number of points without regard to fixed limits.

Whilst the various factors which influence the selection of new equipment are to a large extent self-evident, a complication arises where it is intended to replace existing handling equipment. In such cases a reliable procedure must be followed in order to determine when equipment should be replaced on economic grounds.

Extensive research into equipment replacement policy has been carried out in recent years, particularly in America. The procedure developed by the Machinery and Allied Products Institute (MAPI), for instance, has met with widespread recognition.

There are two basic concepts in the MAPI approach, one being for the "defender", that is the equipment or layout it is proposed to replace, and one for the "challenger", or the proposed equipment of improved design; namely:

- (a) *the defender's adverse minimum*, which is an estimate of its next-year's operating inferiority to the challenger, plus the maintenance charges associated with carrying on for another year, and
- (b) *the challenger's adverse minimum*, based on its "inferiority gradient", that is its deterioration and obsolescence, which, for simplicity, are assumed to accumulate at a constant rate over its service life.

The computation of the defender's and challenger's adverse minima may well form an important part of the materials handling survey. Once these have been obtained the equipment replacement analysis can be undertaken on the following basis:—

| | | | | |
|----------------------------------|---|------------------------------------|---|-----------------------------|
| Defender's adverse minimum | > | Challenger's adverse minimum | = | Replacement is indicated |
| Defender's adverse minimum | < | Challenger's adverse minimum | = | Retention indicated |

Any replacement studies—whether or not by specific formula—involve, however, an estimate of future service conditions and costs. The results of such studies are therefore only as valid as the assumptions on which these estimates are based.

Conclusion

The purpose of this paper has been to present a brief outline of the systematic application of materials handling principles and techniques to modern industry.

Materials handling techniques are relatively simple but this does not mean that improvements are easy to achieve. Besides the need for thoroughness and clear thinking on the part of the materials handling engineer there is the difficult task of gaining acceptance of materials handling proposals.

There is, however, ample evidence that the intensive application of the principles of efficient handling will result in a saving of manpower, a reduction of cost, better deliveries and increased safety to men and materials.

The author feels that he can do no better than to conclude his paper by quoting the main recommendations of the report by the Anglo-American Council of Productivity:

- (a) "That directors, managers, architects and engineers make a study of the best materials handling practice in their own and other industries.
- (b) "That individual companies survey their handling arrangements and determine the handling costs of sample components on each operation rather than treat them collectively as an on-cost of production.
- (c) "That responsibilities be allocated and defined for the materials handling function."

Peak Pressure Diesel Indicator

An instrument styled the "Diesindicator" is the latest addition to the range of diesel engine service equipment manufactured by the Dunedin Engineering Company Limited, 73/75, Mortimer Street, London, W1. It has been designed to register accurate peak and initial cylinder pressures upon a clear dial-type gauge and thus provides immediate visual readings not possible with non-dial forms of indicator, without the need for making complicated adjustments before or during use. It is suitable for low, medium and high speed diesel engines where access to the combustion chamber is provided; is applied simply and quickly and can be used either in vertical or horizontal positions.

As no piston or damper is incorporated, not only is inertia minimized but, in practice, carbon deposit is very greatly reduced with the result that the instrument will continue to operate effectively over long periods without the need for dismantling and cleaning. For example, the Diesindicator provides from 75-100 applications without sooting-up, while the ultimate cleaning of the internal cartridge can be carried out with ease and speed.

Special heat, shock and corrosion resisting materials are used in its construction. The 2,000 lb gauge, graduated both in lb/in.² and kg/cm², is housed in a steel case fitted with a special Bourdon tube. As the accuracy of the instrument depends on the gauge, every gauge is deadweight tested and every assembled instrument is subjected to a dynamic test before final inspection.

The Diesindicator is supplied in a polished wooden instrument case, complete with male and female connectors for standard compression cocks, special spanners and spares and cleaning wires required for servicing the valve cartridge.

Lighter and More Powerful Doxford Engines

More power with greatly reduced weight characterize the future design of the Doxford engine. Scavenge pumps are dispensed with and turbochargers and auxiliary fans are used

THE advent of the largest Doxford engine ever built coincides with important developments in design which result in greater power output for a considerably less engine weight. Although the 700 mm bore Doxford engine is well known and established, the largest of the series, which had its test-bed trials recently, is the first of the type to be built as a turbocharged engine and without scavenge pumps. It is the highest powered Doxford engine built so far and has six cylinders of 700 mm bore and the piston stroke is 2,320 mm. The maximum rating is 10,450 bhp (90% of this for continuous service at sea) at 120 rpm and with a mean indicated pressure of 116 psig. The engine is fitted with two Brown Boveri VTR630 turbochargers.

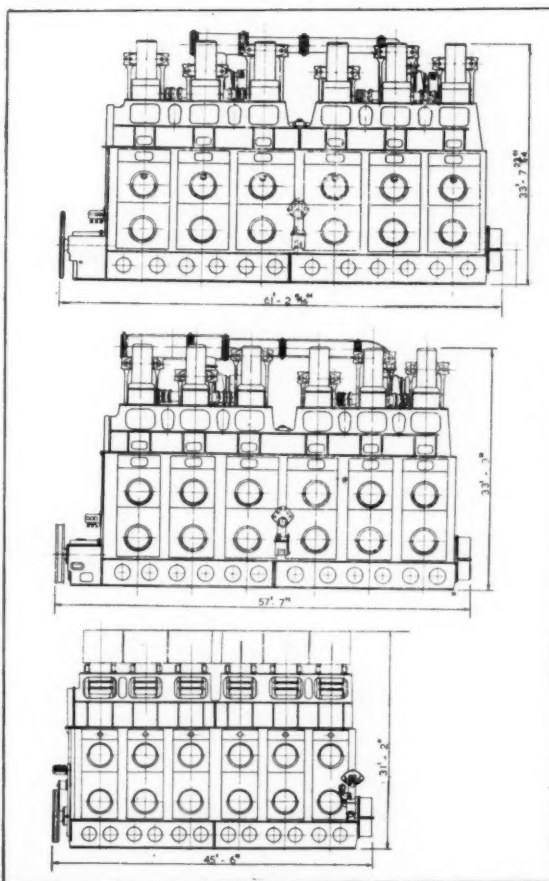
There are at present 24 Doxford turbocharged engines at sea and another 30 building, having cylinder bores ranging from 600 to 700 mm. The original design had reciprocating scavenge pumps operating in series with turbo-blowers, but tests of turbocharged engines in sea service with these pumps disconnected have shown that they can be eliminated with no more than minor modifications to the engine itself. The engine recently tested is the first to be built *ab initio* without scavenge pumps. This change results in a simpler and cleaner layout and achieves a reduction in engine weight of nearly 30 tons coupled with a substantial saving in cost.

To augment the scavenge air supply under slow running conditions, and to provide for continued operation of the engine in the event of failure of one or both of the exhaust turbo-blowers, two electrically driven auxiliary fans are fitted. Only one of these fans is required for slow running, but if both turbo-blowers were to fail the engine could still be run at about 70 rpm with both fans in operation. Without any fan at all the engine can be run at about 30 rpm with good combustion conditions, but with one fan in operation revolutions can be reduced to about 22 rpm. These low revolutions, whilst not always necessary, are sometimes required for canal conditions or heavy manoeuvring.

As a result of experience with turbocharged engines in service, it has been found possible to reduce the cylinder centres without affecting performance or

accessibility. The reduction in overall length and weight which can be achieved by this means is shown in the Table and the outline drawing.

To meet demands for shorter and lighter engines, Messrs. Doxford are now engaged in the production of their future engine. The prototype six-cylinder turbocharged version will commence shop tests towards the end of 1959. Leading particulars of this engine are recorded in the Table from which it will be seen that comparing future designs with existing designs a higher power will be developed from an engine nearly 14 ft shorter and approximately 135 tons lighter.



Outline drawings of Doxford engines showing, from top to bottom, existing design of turbocharged engine having six cylinders of 700 mm x 2,320 mm bore and stroke and weighing 510 tons; the reduced centre design of the same cylinder dimensions and weighing 480 tons; and the future design of 670 mm x 2,100 mm and weighing 375 tons. The rating of the future design is 10,800 bhp as compared with 10,450 bhp for the other two

A COMPARISON OF DOXFORD ENGINES

| | Existing design | Reduced centre design | Future design |
|---------------------|-----------------|-----------------------|---------------|
| Number of cylinders | 6 | 6 | 6 |
| Bore, mm | 700 | 700 | 670 |
| Stroke, mm | 2,320 | 2,320 | 2,100 |
| Maximum rating* bhp | 10,450 | 10,450 | 10,800 |
| rpm | 120 | 120 | 130 |
| mip | 116 psig | 116 psig | 135 psig |
| Overall length | 61 ft 1 1/2 in. | 57 ft 7 in. | 47 ft 6 in. |
| Width of bedplate | 12 ft 4 1/2 in. | 12 ft 4 1/2 in. | 12 ft 2 in. |
| Overall height | 33 ft 7 1/2 in. | 33 ft 3 in. | 31 ft 2 in. |
| Weight (tons) | 510 | 480 | 375 |

*For continuous sea service the recommended output is about 90% of the maximum rating

Laboratory for Elastomers Research

Equipment which will simulate any rubber manufacturing process will enable the development of formulations with optimum processing characteristics

THE new laboratory which the Du Pont Company (United Kingdom) Limited has built at Hemel Hempstead will be devoted to developmental work on neoprene and other synthetic rubbers and rubber chemicals. Officially designated the Elastomers Research Laboratory, it is the first permanent facility to be completed for Du Pont in Europe and will be staffed entirely by British graduates and technicians. Mr. Wilfred P. Fletcher is the manager. The company has a neoprene plant nearing completion in Londonderry, Northern Ireland, and it is expected that the services offered by the laboratory will increase materially when the Northern Ireland plant is in full production.

The laboratory can accurately duplicate most of the processes used by rubber manufacturers throughout the world, being equipped with mills and internal mixers, processing machines such as calenders and extruders, and steamheated hydraulic presses, autoclaves, and circulating-air ovens for vulcanizing.

In addition the laboratory has machines and devices for testing the tensile strength, abrasion resistance, hardness, flex resistance, compression set, and chemical resistance of elastomers and elastomeric compounds, both at the time of manufacture and after ageing under various conditions.

The research and technical staff will be responsible for developing and testing new formulations and processing techniques using Du Pont elastomers, alone or in blends with other elastomers, for the manufacture of specific finished products. In this way experimental formulations with optimum processing characteristics will be developed to produce highest quality at lowest cost.

In addition to testing and research, the laboratory facilities will be used as a demonstration and proving area. Testing of products made from Du Pont synthetic rubbers will be demonstrated on equipment designed to simulate actual service conditions. Another important function will be to work with the rubber industry in Europe in establishing standards of quality.

Neoprene

The only general-purpose synthetic rubber in commercial manufacture in the United States at the beginning of World War II, neoprene was first announced in November 1931 and was first produced commercially in 1932.

Neoprene was developed after nearly a century of research for a synthetic rubber. In 1925, a young Du Pont chemist, Dr. Elmer K. Bolton, heard a paper presented by Father Julius A. Nieuwland, professor of organic chemistry at the University of Notre Dame, before the American Chemical Society. Father Nieuwland was not even casually interested in the quest for a satisfactory synthetic rubber; instead, he was reporting



This electronic equipment can determine almost any of the physical properties of rubber samples from tensile strength to tear resistance and adhesive strength. It is highly instrumented and operates at temperatures ranging from minus 70° to 550° F

on his research on acetylene gas. Dr. Bolton was deep in the subject of synthetic rubber.

The meeting over, the two scientists talked at length. Dr. Nieuwland suggested to Dr. Bolton that he visit the Notre Dame laboratory to get more information about the university's research on acetylene. Back in their laboratory, Du Pont chemists found that Father Nieuwland's process to make divinylacetylene could be modified to produce monovinylacetylene, a compound made by the union of two molecules of acetylene gas. They found that treatment of monovinylacetylene with hydrochloric acid resulted in a previously unknown chemical which was called chloroprene. It was soon found that chloroprene could be converted into a rubber-like solid superior to natural rubber in many respects. This product is known by the generic name neoprene.

The effect of the discovery was much greater than it seemed at the time. The announcement of neoprene in 1931 stimulated much other research, both in Europe and America, which led to the development of other synthetic rubbers made by different processes. Production each year from 1932 to 1940 doubled that of the previous year except in the recession year of 1938 when a somewhat smaller increase was made.

Neoprene compounds resist deterioration from oils, greases, oxygen, ozone, and various chemicals; and neoprene products have excellent resistance to abrasion and wear, to cutting, chipping, and tearing, and they

stand up in sunlight and on exposure to the weather. Neoprene can be compounded to retain much of its flexibility at sub-zero temperatures. At the same time, its compounds are resistant to heat, and specially compounded products are flame-resistant; they do not support combustion. It can be formulated with the softness of a common rubber band or the hardness of a solid tyre.

Dissolved in a solvent, neoprene can be applied like a paint; it has proved to be a durable protective coating for equipment in chemical plants, plating shops, and other locations with corrosive, fume-laden atmospheres.

Neoprene is particularly well adapted for use in conveyor belts. It is being used successfully by architects for gaskets to seal glass and metal panels used extensively in skin wall construction. Several of the major tyre companies are now using neoprene in sidewalls to combat destructive ozone and oxidation found in the atmosphere—the major causes of tyre cracking.

Hypalon

Hypalon synthetic rubber is the newest Du Pont entry in this field. Known chemically as chlorosulfonated polyethylene, Hypalon offers complete resistance to ozone and can be produced in a variety of colours. The new synthetic rubber is being used commercially in coated fabrics, maintenance coatings and paints, white sidewall tyres, spark-plug boots, gaskets, patio tile, and a number of other commercial and industrial uses.

Viton

Viton is a new fluoroelastomer developed for service in oils, fuels, solvents, and chemicals at temperatures over 400°F.

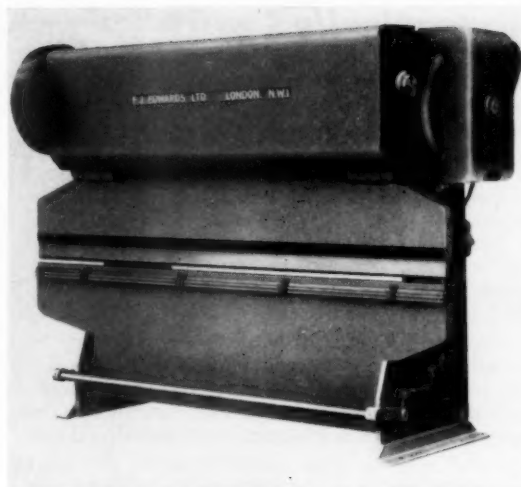
It has a dependable performance at temperatures of 400°F and upwards, resistance to most oils, chemicals, solvents and exotic fuels at temperatures of 400°F and above, good mechanical properties, and excellent resistance to ozone, oxygen, and weathering.

It resists temperatures up to 450°F in continuous service and up to 600°F in intermittent service.

Notable among its mechanical properties are low compression set and good tensile strength. Specimens compressed 25% and held 70 hr at 250°F recover to within 90 to 97% of their original dimension, making them good seals at high temperatures. Tested at room temperature, Viton has a tensile strength in the range of 2000 to 3000 psi and ultimate elongation varies from 100 to 400% depending on hardness. (Vulcanizates of Viton can be made in any hardness from 60 to 95 durometer).

New Press Brakes in Seven Sizes

An entirely new series of press brakes, to be marketed under the name of "Besco-Truebend", have been designed and registered by F. J. Edwards Limited. The capacity is 72 in. \times 16 S.W.G. \times 20 tons up to a maximum capacity of 120 in. \times $\frac{1}{8}$ in. \times 80 tons pressure. The seven sizes in between are 72 in. \times $\frac{1}{8}$ in. \times 40 tons, 96 in. \times 14 S.W.G. \times 40 tons, 120 in. \times 16 S.W.G. \times 40 tons, 72 in. \times $\frac{3}{16}$ in. \times 60 tons, 96 in. \times $\frac{1}{8}$ in. \times 60 tons, 120 in. \times 12 S.W.G. \times 80 tons and 96 in. \times $\frac{3}{16}$ in. \times 80 tons. These bending capacities are taken over the full



The Besco-Truebend new series of press brakes

tool width and the thickness is naturally increased on shorter plates taken between the side frames which are arranged to receive plates straight through.

This comprehensive range gives the machines wide application, not only in the form of the material handled, but to some extent in the type of work handled, for the 20 ton brake is most suitable in size and cost for the smaller works with lighter weight and low to high production.

The press brakes are built from heavy rolled steel plates, welded and bolted together to give rigid strength and eliminate deflexion. Deep gaps from 6 in. to 10 in. in the side frames permit the forming of plates longer than the bed in more than one operation. The bed is wide and machined full length and dovetailed slots front and rear will accommodate die setting plates and gauges. Tool height setting is by ram adjustment and in the case of the 20 and 40 ton machines this adjustment is by hand operated worm and worm wheel gear reduction. The remaining five larger machines have the ram adjustment by motor through worm and worm wheel. A setting scale and indicator is provided on all machines.

The machines are arranged for V-rope motor drive through heavy spur gearing enclosed in a box and running in oil. The balanced flywheel, which is machined all over, incorporates a disc-type clutch operated by a full length treadle through a series of levers, giving light but positive control to the machine. The brake is connected to the treadle mechanism, allowing the operator to "inch" the ram and maintain complete control during the bending operation.

A band brake is fitted to each of the 20 and 40 ton machines, while the 60 and 80 ton models have shoe brakes. Control of the main drive motor and auxiliary ram adjusting motor, when fitted, is by flush-mounted, push button stations on a contactor box. Single shot lubrication is fitted and steel guards cover the gears, drive and crankshaft. Illustrated leaflets with full specification are available from the manufacturers F. J. Edwards Limited, 359-361, Euston Road, London, NW1.

Electronically Controlled Heavy Duty Drilling Machine

A new electronically controlled drilling machine capable of accurately positioning and drilling holes up to 2 in. dia in thick steel in a fraction of the time taken by a skilled operator working a conventional radial drill, has been developed by E.M.I. Electronics Limited, and Wadkin Limited. Known as the E.M.I./Wadkin electronic positional drilling machine Model TCD 1, the equipment has a large worktable measuring 3 ft 6 in. \times 5 ft 6 in. and has been designed specially to exploit the high degree of accuracy provided by the E.M.I. control system.

Unlike conventional drills, it is not necessary to go through the lengthy procedure of drilling a small pilot hole, followed by progressively larger ones, until the required size is reached. Large holes can thus be drilled to very fine tolerances in a fraction of the normal time.

As with E.M.I.'s other control systems, this machine is automatic and operates from either punched tape or dial settings. No marking out or drilling jigs are required. Nor is an external computer needed to carry out even complicated programming, as the E.M.I. system incorporates what is in effect a "built-in" computer.

The TCD 1 has an all geared drill head mounted on a cross beam, which is carried on twin vertical columns for rigidity. The table, which has nine $\frac{5}{8}$ in. BS tee slots at 4 in. centres, measures 3 ft 6 in. \times 5 ft 6 in. and is mounted on precision, hardened and ground roller chain tracks, which are protected by a roller blind system, and provision is made for the recirculation of cutting fluids.

The table is driven via a precision, hardened and ground 2 in. dia leadscrew and preloaded recirculating ball nut. The $1\frac{1}{2}$ hp motor, which drives the table through reduction gearing, is governed by a self contained Ward Leonard Set mounted on the machine, which is controlled from the electronic cabinet. The cross transverse of the head is furnished with similar equipment to that of the table.

Precision automatically operated locking devices are provided on both the table traverse and the cross traverse of the drill head to lock both movements during drilling operation. The complete cross beam and drill head unit has power rise and fall from a $1\frac{1}{2}$ hp motor, providing a rate of 15 in. per min. The table is of substantial cast iron construction and is designed to support components of up to 5000 lb.

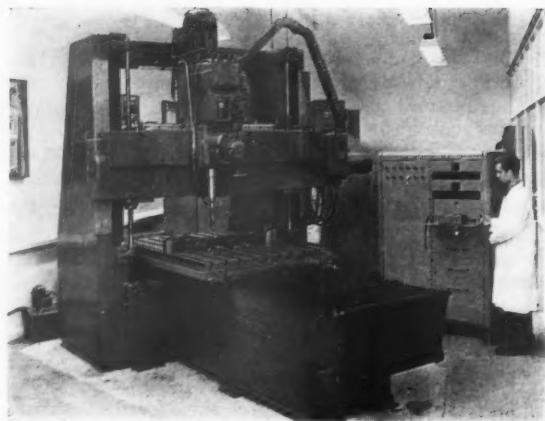
The final measuring elements are mounted directly on the machine bed, and the associated coarse measuring systems in a reduction gearbox driven from the leadscrew.

The machine is fitted with an Archdale head modified for remote control. The spindle has a No. 5 Morse Taper, and is driven by a 5 hp motor, with a speed range of 60-1500 rpm in twelve increments.

There are six feed rates provided from 0.004 in. to 0.030 in. per revolution. The feed and speed change is manually operated, but the drilling feed cycle is initiated from the control cabinet.

Method of operation

A table of x and y axes dimensions is prepared. The first tabulated x and y dimensions are the alignment points necessary to enable the accurate location of the



General view of the E.M.I./Wadkin electronic drilling machine which has been specially designed to enable full advantage to be taken of the high degree of accuracy provided by the E.M.I. control system. The machine is controlled entirely from punched paper tape and eliminates the need for a skilled operator

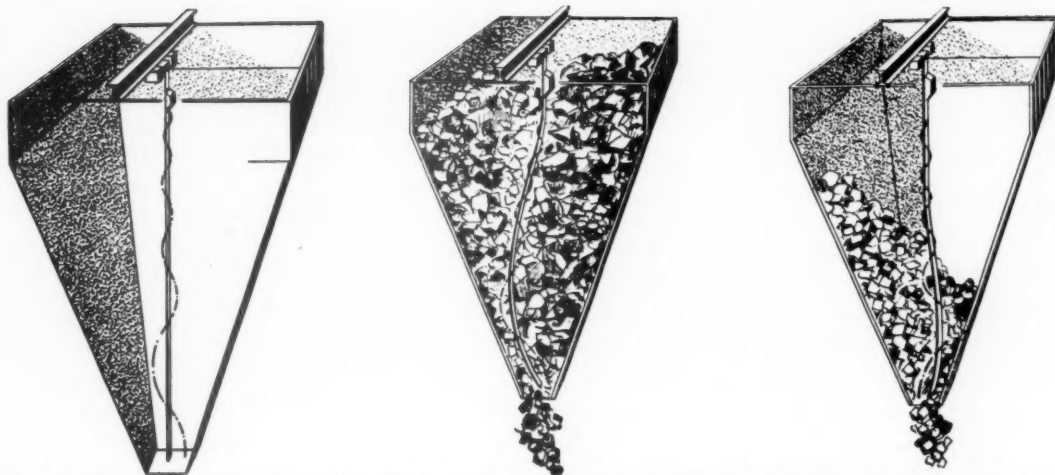
workpiece with respect to the table datum. These are followed sequentially by the x and y dimensions of all the holes to be drilled. Where practicable, all holes of the same dimension should be grouped to minimise the number of tool changes.

The table of dimensions is typed-out on a modified teleprinter which produces the punched paper tape used to control the machine. The workpiece is then located on the table relative to the table datum using the programmed alignment points, these may be machined faces, cast bosses or specially machined flats. The correct tool is fitted, speed, feed, and depth set and the start button pressed, the machine will then commence and automatically cycle through the first group of the programme. After the first cycle has been completed the machine automatically stops to enable the next tool to be fitted before the next series of operations. For simple 'one off' jobs, it may be considered impractical to produce a tape and for this reason dials are provided to individually set the co-ordinates required.

The price of the new machine, complete with electronic control, is expected to be in the region of £10,000 when full production begins. This compares favourably with the price of a conventional drilling machine of this type and illustrates how, by designing equipment specifically for electronic control, the cost can be greatly reduced.

Vibrating Reed Keeps Bunkers Flowing

To promote efficient discharge from storage bunkers containing powdered, granulated, or lump materials that tend to arch, pack or funnel, the Sinex Engineering Company Limited, of North Feltham Trading Estate, Feltham, Middlesex have developed a new kind of vibrator which is said to be particularly effective when applied to coal or ore bunkers, and large concrete bunkers where external vibrators cannot be applied. It can be combined with external vibrators for dealing with very difficult materials. Among its special advantages are accessibility of the power unit, ease of replacement when necessary, and the fact that it offers no obstruction to the material in the hopper.



At left is shown schematically the vibration impulses travelling down the reed. At centre is shown the beginning of discharge causing differences in pressure of material on the reed which bends, thus moving the tip to a different position. At right a partially discharged bunker is seen with the bulk of the material on one side bending the reed so that the vibrating tip bends towards a point beneath that bulk, thus ensuring efficient discharge

The device consists of a rotary electric vibrator attached to a steel reed which hangs down into the bunker. The complete assembly is suspended from a rolled steel joist across the top of the bunker by means of anti-vibration mountings which isolate the hopper structure from vibratory effects. When the equipment is in operation, the vibration passes down the reed with increasing amplitude, reaching a maximum at the lower end where the material has a tendency to arch. As vibration loosens and releases the material, the pressure of the latter on the reed varies and causes it to bend and move about the hopper.

Constructed of mild steel, the reed is made up to suit the depth of the hopper for which it is required. Its dimensions vary between 18 and 24 in. wide, $\frac{1}{8}$ to $\frac{3}{8}$ in. thick and up to 60 ft in length.

Industrial Power Transistors

Two new power transistors intended for use in heavy-duty industrial and military applications such as in power-switching, d.c.-to-d.c. converter, voltage-regulator, and power-supply circuits, and as relay-actuating devices has been introduced by RCA Great Britain Limited, Lincoln Way, Windmill Road, Sunbury-on-Thames. These transistors may also be used in audio-frequency oscillator service, and in large-signal class A or in class B push-pull audio-frequency amplifier service.

They are of the germanium p-n-p alloy type and feature a maximum peak collector current rating of —10 amperes and a maximum peak collector-to-base voltage rating of —80 and —100 volts, respectively. They differ in maximum peak collector-to-base and collector-to-emitter voltage ratings to suit particularly those applications requiring high voltages.

In a typical common-emitter type of "on-off" power switching circuits with a d.c. supply voltage of 28 volts and a driving power of only 42.6 milliwatts, these transistors can provide a power output of 54 watts with a power gain of 31.3 decibels.

In a typical d.c.-to-d.c. converter circuit with a d.c. supply voltage of 28 volts and a d.c. supply current of 4.2 amp, transistors can provide a d.c. output voltage of 420 volts with an efficiency of 88%.

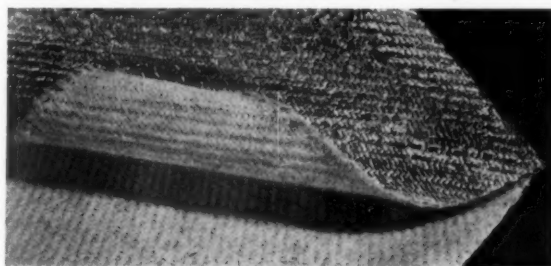
The design utilizes a special mount structure in which the collector is electrically and thermally connected to a mounting flange which provides for good electrical contact and excellent transfer of heat from the transistor junctions to the heat sink.

New f.h.p. Motors

A new range of fractional horsepower motors, which comply with B.S. 170 and have the mounting dimensions of American standard "NEMA 48", is being made by Crompton Parkinson Limited. The new motors, designated T.45, have a centre height of only three inches; although motors of the same basic diameter have been produced in the U.K. for some time, it is thought that the T.45 range is the first to employ "NEMA 48" dimensions.

The range makes provision for seven methods of mounting, including solid-foot, resilient, end-face, and oil burner flange. On the foot-mounted versions, a new shape of foot is employed, and is made of steel having a rigidity comparable with that of heavy cast-iron.

To comply with NEMA standards, the motors have a $\frac{1}{2}$ in. dia shaft extension. Bearings are $\frac{3}{8}$ in. dia and this allows $\frac{5}{8}$ in. dia shafts to be provided at either end of the machine when required.



ALUMINIUM-FACED ASBESTOS CLOTH.—Several qualities of woven asbestos cloths produced by Turner Brothers Asbestos Company Limited, of Rochdale, Lancs, are now available having a coating of bright and highly reflective aluminium. This innovation should be of interest to industries concerned with thermal insulation, particularly those connected with shipbuilding and marine refit, as well as gas turbine and aircraft manufacture. These special fabrics are also being adopted for fire-fighting and other protective clothing applications



One of the defibrators in which wood is reduced to fibre. The Crompton Parkinson motor is of 250 hp



The wet lap forming machine (left) and ovens and humidifier (right). One of the rail-directed trolleys can be seen in the background

Automation for Hardboard Manufacture

The first fibre building board was made at Sunbury-on-Thames in 1898 by The Patent Impermeable Millboard Company Limited. Recently, the same firm (now known as P.I.M. Board Company Limited), commissioned the first fully automatic hardboard manufacturing plant to be erected in Great Britain since the war. The plant is in operation for 24 hours per day and has increased output threefold

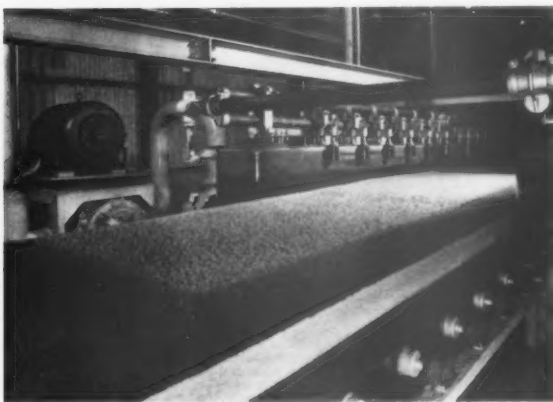
THE hardboard manufacturing process starts when for Sovereign board, Scotch fir thinnings are reduced first to chips and then to fibres. The fibres are ground to an exact degree in three defibrator machines, the wood chips being passed through a steam pre-heater and then forced between two high speed rotating discs, the grinding faces of which are adjustable and under extremely fine control. At the discharging end water is added to the fibres and the refined diluted stock is then pumped through overhead pipe lines to the board making plant. The refined pulp is temporarily stored in 5,000 gal storage chests equipped with agitating equipment.

The firm's highest quality medium hardboard, Sundeala, is made entirely from mechanical wood pulp. Before this type of pulp arrives at the board making plant, it is first further refined and circulated in cylindrical

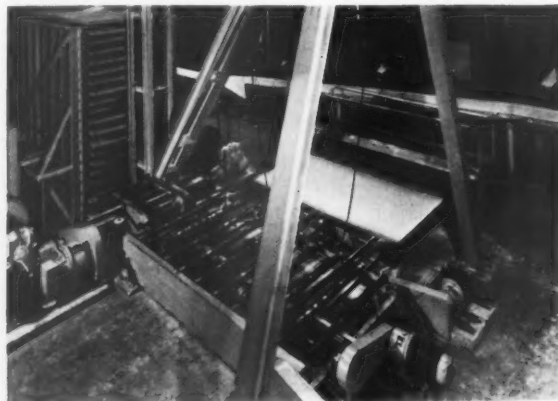
beaters when a sizing medium is added and mixed into the pulp by means of a rotary mixer.

When the pulp, Sundeala or Sovereign, arrives at the board making plant, automation takes over. On the wet lap forming machine the water content in the pulp is reduced by a vacuum pump, and the pulp is then formed into the required thickness and width entirely under automatic control. It becomes semi-solid and is sawn into oversize widths and lengths as it passes along the wet lap conveyor to the hydraulically operated hot platen press.

The wet laps are moved automatically from the forming machine conveyor on to a wire and plate which is then automatically loaded into the charging rack. At the correct time in the duty cycle the charging rack auto-



Hardboard on the wet lap forming machine before it is rolled and sawn



A piece of sawn hardboard travelling towards the loading end of the hot press. Several loaded trays waiting to enter the press can be seen on the left of the picture

matically feeds 20 combinations of wet lap, wire and plate into the press. Depending upon the type of hardboard being produced, the boards stay in the press for times up to 12 min at pressures between 500 to 750 psi depending on the board thickness.

After the pressing cycle, the hardboard is moved out of the press by an automatic discharger arranged to load each combination of board, wire and plate on to a conveyor. At a preset point on the discharging conveyor the board is separated from the wire and plate and loaded into a rail-directed trolley. The wire and plate are passed

under the pressed board to another conveyor which directs them back into the loading section.

The loaded trolley passes into the heat treatment oven and after a certain time under controlled temperature it is passed into the humidifier. After the boards have reached a stable condition they are transferred to the inspection department and then sawn to size and despatched.

The complete electrical installation, including some 2000 hp of electric motors was supplied by Crompton Parkinson Limited.



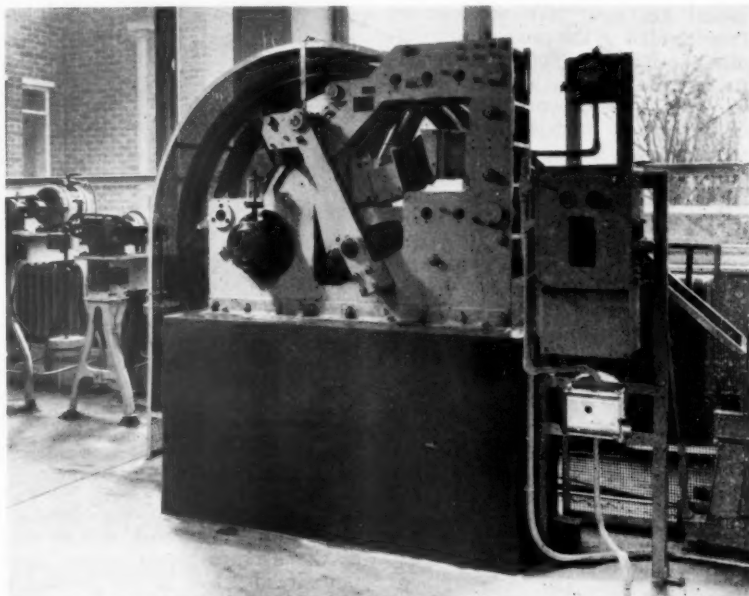
The new Metalastik's office and research building

Rubber to Metal Bonding Research

Coincident with their 21st anniversary Metalastik Limited, the specialists in the field of rubber-to-metal bonding have opened a new office and research block at their Evington Valley Road Works, Leicester. The research laboratories are fully equipped to carry out extensive tests on standard test pieces and on actual production components thus co-ordinating the work of the company's chemists in establishing design data for the numerous natural and synthetic rubber compounds in use.

Fatigue testing is a very important aspect of the work of the department and for this purpose Metalastik Limited have designed a number of machines to enable accelerated life tests to be carried out on components under loadings which simulate operating conditions. The machine illustrated here is for fatigue testing rubber suspension units for road and railway vehicles. The component in this particular test is a bolster suspension unit for London Transport tube trains being subjected to a constant amplitude of ± 0.75 in. at 90 rpm. Metalastik bonded bushes of the type fitted in the pivots of vehicle suspensions, shaker screens and vibratory conveyors are subjected simultaneously to radial and torsional loads on a special four-station machine which reproduces differing load conditions.

The stiffness of bonded components must be controlled to close limits to ensure that the correct



This machine has been specially designed to simulate service conditions and is used to test rubber suspension units for road and rail vehicles

insulation characteristics are provided. A Mills testing machine enables large sandwich mountings to be loaded up to 25,000 lb. Dynamic stiffness and vibration damping characteristics of Metalastik components are tested on another specially developed machine. Concrete blocks are excited into vertical oscillation and a resonance curve of amplitude is plotted against frequency.

An extensive range of vibration and shock measuring equipment is available for diagnosing vibration problems and particularly torsional vibrations of high-speed oil and petrol engines for vehicles of which the department has probably unrivalled experience.

Apart from development work, the department tests and records the properties of the components manufactured by the company and is responsible for devising the quality control tests for the production lines.

Sprayed Thermal Insulation

Daltolac-41 is a new polyether resin specially designed for use with Suprasec-D to produce rigid polyurethane foams by the spray process. The low-density (3-5 lb/cu ft) foams produced show excellent thermal insulation properties and have very good resistance to water uptake and water vapour transmission. They are admirably suited for the thermal insulation of roofs and walls, to which they are easily and conveniently applied by spraying. Only the normal precautions are necessary in such application. For this work the Daltolac-41/Suprasec-D foams offer substantial economic and technical advantages.

The makers of Daltolac-41 and Suprasec-D, the Dyestuffs Division of Imperial Chemical Industries Limited, have designed special equipment (now available commercially) for spraying the foams.

New Induction Heaters

Experience has shown that the variety of work potentially suitable for induction heating and requiring a radio-frequency generator is so great that efficiency of operation cannot be obtained in every instance from a single model. For this reason the Delapena Model E 9/12 induction heater, which has previously been available as a single model has now been replaced by three models of the same power output but having different characteristics making each suitable for a particular class of work. The availability of three models in the power range now makes possible the greatest economies in production by allowing users to select the model which suits the predominant type of work to be performed.

The new models are known as the E 9/12 HC, E 9/12 LC and E 9/12 H respectively. They are generally similar in design but differ in the impedance characteristics of the r.f. circuits and in the provision, on two models, of an additional power control. Each model is provided with simple means of matching its output to as wide a variety of work as possible within its power and output impedance limitations, making it extremely versatile in use and maintaining its efficiency over a wide range of applications.

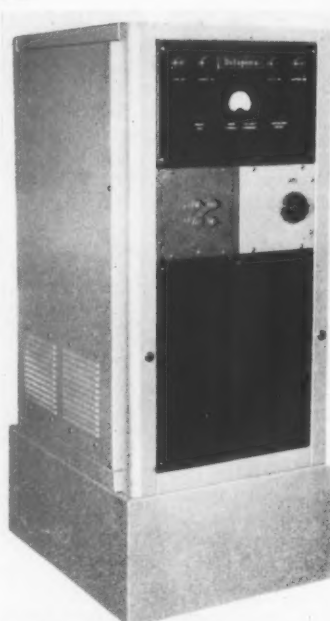
Matching the load

Using alternative work coils or inductors, each set has two pairs of output terminations which provide for operation with as many different types of load as possible. For loads of comparatively low impedance the two pairs are connected in parallel; for loads of higher impedance they are connected in series. A pair of paralleling plates and a series link to facilitate the alternative connections are provided.

When dealing with non-ferrous metals and certain other types of work, it is sometimes necessary, in order to obtain optimum efficiency, to increase the kVA circulating in the work coil by the use of boost condensers. These condensers are fitted internally and are brought into circuit by connecting a link.

Power ratings

Each model has a maximum continuous power output (to BS 1799:52) of 9 kW, but has also the feature, standard on the Delapena range, of extra power availability for intermittent operation.



Delapena induction heater, Model E 9/12 HC. Model LC is similar, Model H is without the power control handle.—Delapena & Son Limited, Cheltenham

This intermittent rating gives a reserve of power allowing operation at an output of up to 12 kW so long as the average power output does not exceed 9 kW. If this average is exceeded the power is automatically switched off and an interval of two minutes must elapse before power can again be drawn from the set. This two-minute interval governs the duration of heating at loadings in excess of 9 kW. The maximum uninterrupted duration of heating at 12 kW, for example is 6 min, and at 10 kW, 18 min. If, however, as in many practical applications, a production time cycle has periods of heating at between 9 and 12 kW alternating with regular stand-by interval or periods at lower loadings, so that an average loading below 9 kW is maintained, an indefinitely continuous cycle is possible.

Output current control

All standard Delapena induction heaters, with the exception of Model E 9/12 H described below, are fitted with an on-load output current control which allows continuous fine regulation of the power output over a power ratio of 10:1 during the heating cycle. This is of particular value for many processes involving ferrous metals which change their heating characteristics at the Curie

point, the temperature above which the iron ceases to have magnetic properties. When this temperature is reached the coupling efficiency of the inductor coil falls and a much greater current must be induced into the work-piece to achieve the same rate of heating. The output current control provides a means of increasing the current by varying the ratio of the r.f. output transformer.

The standard output current control is for manual operation but automatic means of operation can readily be incorporated where the set is to be used in fully automatic production lines or to meet other special requirements.

Model HC

This model is fitted with an on-load output current control; it is suitable for a wide range of general work and can be used effectively with inductors having a good range of impedance values. It is particularly efficient when used with an external r.f. transformer to supply power to the Delapena patented intensifier, used for hardening gear teeth, machine tool slideways and many other precision surface hardening applications. This efficiency extends to any applications using transformers or high-impedance (large or multi-turn) work coils.

Model LC

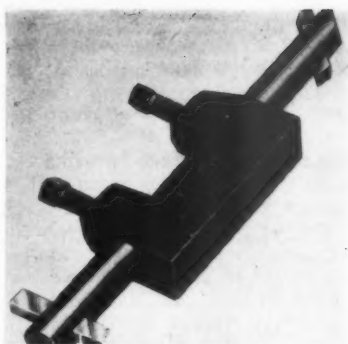
This model is also fitted with an on-load output current control, but is more suitable for a range of applications, ferrous or non-ferrous, in which small low-impedance work coils are used.

Model H

A high-impedance set not fitted with an output current control. This set is efficient for heating non-ferrous metals (or ferrous metals below about 770° C) in any application within its power range requiring the use of an r.f. transformer or other high-impedance loads. Where a set is to be used wholly for soldering or brazing applications, for instance, the fitment of an output current control would be an unnecessary complication.

New Eclipse Boring Tool Holders

A notable addition to the excellent range of Eclipse tools has been made in the form of three multi-purpose boring tool holders. Designed for use on English pattern lathes the new tools exhibit the finish and quality,



Eclipse boring tool holder

arising from the utmost care in manufacture and the use of high-grade materials, associated generally with the products of James Neill & Co. (Sheffield) Limited, Sheffield 11. The cutter bar, which is rigidly held in a fixed Bee block by two clamping screws, can be adjusted or removed without interfering with the setting of the holder itself. Each holder is supplied with a double-ended type of cutter bar in which the two cutter slots are machined at angles of 90° and 45° respectively; in both cases the cutter is held in position by means of an Allen grub screw.

The three sizes of holder are supplied with $\frac{3}{8}$ in., $\frac{7}{16}$ in. and $\frac{9}{16}$ in. dia cutter bars respectively which, in turn, hold cutters $\frac{1}{8}$ in., $\frac{3}{16}$ in. and $\frac{1}{2}$ in. square. In addition to holding the cutter bars with which they are supplied, the two larger holders will also grip securely the cutter bars supplied with the smaller holders. Each holder will also accommodate all the four sizes of Eclipse boring bar ($\frac{3}{16}$ in., $\frac{1}{4}$ in., $\frac{5}{16}$ in. and $\frac{3}{8}$ in. diameter) as well as other tools such as drills and reamers within the capacity of the holder.

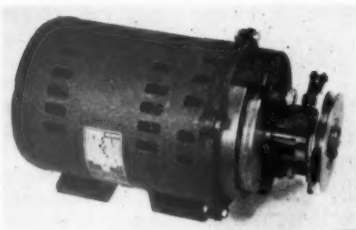
A further useful feature is the provision of two tapped and counter-sunk holes, complete with screws, on the underside of each holder for the purpose of facilitating the attachment of packings to suit any particular lathe centre height.

Each holder is supplied with two Eclipse H3 cobalt high speed steel square cutters, which are jig ground on one end only for immediate use at 90° and 45° respectively. Similarly ground spare cutters are also available and are now included in the standard range of Eclipse lathe tools.

Each holder is individually packed together with a clamping screw spanner and an Allen key, in a strong and attractive cardboard box.

High Speed f.h.p. Clutch Unit

A new Mardrive unit for use on high-speed coil winders, instrument lathes, conveyors, sewing machines etc., has been added to the range of clutch units manufactured by the Marine Engineering Company (Stockport) Limited. Provided with a Crompton Parkinson f.h.p. motor it gives slow and very sensitive starting or extremely quick starting according to requirements.

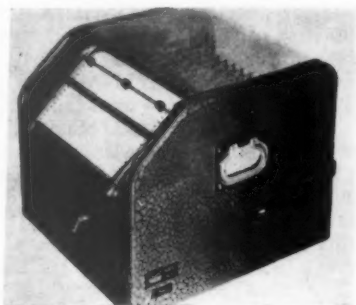


Mardrive clutch unit with end cover removed

Outstanding characteristics of the new clutch unit are low weight and compactness, a flywheel specifically designed to match the run-up torque and load factor of the motor, a completely detachable clutch, and an adjustable control for rate of acceleration and braking.

Automatic Production Recorder

An aid to accurate production planning in the form of a multi-channel recorder made by Maihak, of Hamburg, has been introduced by Smail, Sons & Co. Limited of India Street, Glasgow. Up to fifty production check-points can be connected, all working simultaneously and independently and all transmitting impulses to the main control unit. Every step in production can be shown and recorded on a waxed chart, including such conditions as

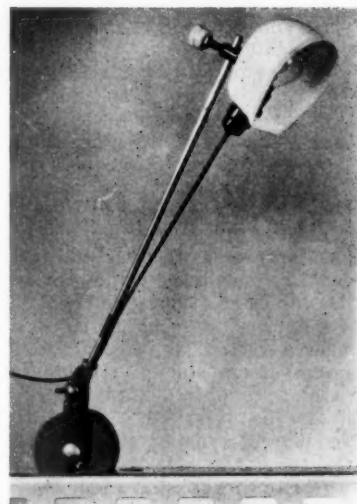


50 channel multiple recorder for use with production lines

running periods, delays, schedule performance and time, thereby providing a complete picture of production and progress throughout 24 hours.

Information is recorded at a central point, say on the production director's desk. Each of the fifty relays is equipped with a high and low resistance winding and two change-over contacts, and there are automatic switches and a time recorder.

Complete with printer, the multi-channel recorder costs approximately £2,300.



MAGNETIC SAFETY LIGHT.—A low voltage adjustable light with a magnetic base is being made by The Silvasafe Company Limited, 218A Monument Road, Birmingham, 16. The magnetic grip, which will hold it in any position, makes it very suitable for use in either the production shop or the toolroom. The 21 watt bulb is in a Perspex shade. The holder can be clamped anywhere and at any angle on the adjustable rod.

Skydrol Resistant Rubber

At the request of Monsanto Chemicals Limited special synthetic rubber compounds for resistance to Skydrol hydraulic fluids have been developed by Precision Rubbers Limited of Bagworth, Leicester. O-ring seals produced from these compounds were submitted and as a result of the tests carried out by the Douglas Aircraft Company Limited, it has been confirmed that Precision Rubbers' grade X213X is recommended for use with Skydrol 500. Further grades submitted by Precision Rubbers Limited are at present also undergoing tests.

Nuclear Marine Propulsion

A review of developments in America

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F.,
Consulting Engineer

IN recent issues of this journal the writer has published the following series of contributions on nuclear power projects:

- (a) A comparison of the design data of nuclear power stations in Great Britain.
- (b) A chronological survey of the principal researches and developments on atomic and nuclear energy (1803-1958).
- (c) Comparative data on the total cost of generation of conventional and nuclear power stations.
- (d) Steam plant for nuclear power stations.
- (e) A review of the progress in large nuclear power stations in U.S.A.

During the past decade much original and intensive research has been directed specially to the application of nuclear power plant to marine propulsion. Consequently, it seems that the above series of contributions would be incomplete without presenting the advances in the propulsion of naval and merchant vessels. A number of countries in many parts of the world have been engaged on actual projects, research programmes or special design studies, relating specifically to nuclear marine propulsion. Consequently it is proposed to present the progress of each country separately. America has played a major role in these developments. As pioneers in this field their spectacular achievements are to receive first consideration. During the past few years America is the only country to have produced not only the first but also a fair number of nuclear-powered submarines. Their success has been beyond expectations and this has been clearly demonstrated by exceptionally long periods of submerged operation. The technical excellence of the design and the manufacture and the unique performance of these nuclear power plants have attracted the attention of the entire world.

America was the first to produce and to put into active service a nuclear-powered vessel, a submarine the phenomenal success of which was due to the foresight, enthusiasm and determination of Rear Admiral Hyman G. Rickover of the United States Navy. He had become known internationally as "The Father of Nuclear Marine Propulsion". It is of particular interest to recall at this stage the circumstances which gave him his first opportunity of concentrating ultimately for so many years on the design and construction of nuclear plants for naval vessels.

During World War II Rickover, then a captain, was engaged in the Bureau of Ships. In 1946 he joined, at his own request, the Atomic Energy Commission's Clinton Laboratory (Oak Ridge National Laboratory). His main object was to study reactor physics for he had in mind a nuclear power plant for the propulsion of a submarine. The Atomic Energy Commission (AEC) took over "Atomic Activities" officially on January 1, 1947.

Shortly afterwards Rickover was promoted to Rear Admiral, responsible for nuclear marine propulsion. Under his leadership progress was rapid.

1. Prototype reactor for the first nuclear-powered submarine "Nautilus"

The pressurized light water moderated and cooled reactor was the first power system to be developed for a significant power output. It was first proposed by Dr. A. M. Weinberg of Oak Ridge National Laboratory in April, 1946. The chronology of the prototype is given briefly below:

1946 (April): Commencement of the initial study on the application, the development and the technological problems of this type of reactor.

1948 (April): The nuclear power unit was complete for power production and this type was finally approved for submarines.

1948 (April 2): Vice-Admiral E. W. Mills, Chief of the Bureau of Ship USN, addressed the Undersea Warfare Conference to obtain sanction on the development of the nuclear power plant for a submarine. This speech marked the formal start on the nuclear power plant for the "Nautilus".

1948 (June): Westinghouse Electric Corporation received the contract from the Bureau of Ships to proceed with the development, engineering design and construction of the land-based submarine thermal reactor STR Mark I and STR Mark II for the submarine "Nautilus".

1948 (August): The Bureau of Ships awarded the contract for the research work to AEC.

1949: Westinghouse Electric Corporation began the actual development work early in the year.

1950 (August): Commenced the construction of STR Mark I at AEC's National Reactor Testing Station at Idaho Falls, Idaho. Almost on the same day a law was signed authorizing the construction of the first nuclear-powered submarine USS "Nautilus", SSN-571, powered by STR Mark II.

1951 (August): The Electric Boat Division of the General Dynamics Corporation was awarded the contract for the design and the construction of "Nautilus".

1952 (June 14): Laying of the keel of the "Nautilus".

1953 (March 30): Land-based prototype reactor, Mark I, went critical.

1953 (May 31): First production of substantial power of Mark I.

1953 (June): A sustained full power run was successfully conducted, corresponding to a submerged Atlantic crossing.

1954 (January 21): Launching of the "Nautilus" with Mark II. This nuclear power unit was nominally a duplicate of Mark I. However many changes in the design had been incorporated.

1954 (September 30): Completion of the "Nautilus".

It is obvious from an examination of the above dates that both the nuclear power plant with its immense research programmes and the vessel have been built in an exceptionally short period.

2. Essential particulars of the submarine "Nautilus"

The plant consists mainly of one pressurized light water moderated and cooled reactor, having two primary loops with two heat exchangers and two sets of conventional geared turbines each driving a propeller.

1. Year of contract, 1952
2. Laying of keel, June 14, 1952
3. Launching, January 21, 1954
4. Completion, September 30, 1954
5. First time propelled solely by nuclear power, January 17, 1955
6. Builders, Electric Boat Division of the General Dynamics Corporation, Groton, Connecticut
7. Designer and manufacturer of entire power plant including the reactor, Westinghouse Electric Corporation
8. Dimensions and particulars of vessel:
 - (a) Length, 323½ ft
 - (b) beam, 27 ft
 - (c) draught, 22 ft
 - (d) displacement
 - (1) light, 2975 tons
 - (2) standard (surface), 3200 tons
 - (3) submerged, 3747 tons
 - (e) Maximum diving depth, 700 ft
 - (f) Under-water speed, 23 knots
 - (g) Number of propellers, 2
 - (h) Total shaft horse power, 13,400 shp
 - (i) Normal complement (12 officers and 89 men), 101
 - (j) Torpedo tubes
 - (1) number, 6
 - (2) diameter, 21 in.
- 8a. Particulars of reactor:
 - (a) Number, 1
 - (b) Rating (electrical), 18 MW

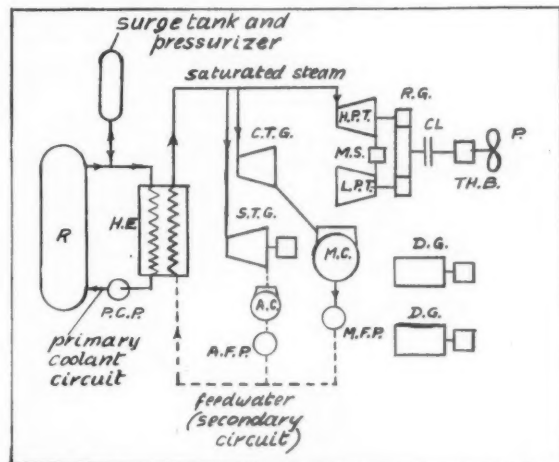


Fig. 1.—Diagrammatic arrangement of the power and propulsion plant for a single loop for the nuclear-powered submarine U.S. "Nautilus". R, reactor; H.E., heat exchanger; H.P.T., high pressure turbine; L.P.T., low pressure turbine; M.S., moisture separator; M.C., main condenser; R.G., reduction gear; CL, clutch; P.M., propeller motor; T.H.B., thrust block; P, propeller; C.T.G., coolant turbo-generator; S.T.G., service turbo-generator; A.C., auxiliary condenser; M.F.P., main feed pump; A.F.P., auxiliary feed pump; P.C.P., primary circulating pump; D.G., diesel generators (two 300kW).

- (c) Core, arranged vertically in a stainless vessel
- (d) Fuel, highly enriched uranium of about 40% enrichment
- (e) Fuel element, zircaloy clad uranium
- (f) Material of the pressure vessel, stainless steel
- (g) Control rods, mounted vertically and operated manually or automatically
- (h) Shielding, the main shielding consists of lead or polythene
- (i) Distance travelled with first core, 62,559 miles

9. Propulsion plant (see Fig. 1). Consists of two conventional geared turbine units, one for each propeller. The slow speed shaft of the reduction gear is connected by a clutch to the propeller shaft. On the same shaft, between this clutch and the main thrust block, is inserted a propulsion motor which can drive independently the propeller. This is achieved by declutching the main turbines and their reduction gears from the propeller shafts. These electric motors are supplied with current from diesel generator sets.
10. Diesel generators. Two 300kW sets are used for charging the batteries and for supplying power to the propulsion motors.

3. Chronological record of the performance of the "Nautilus"

1955 (January 17): First time solely propelled by nuclear power. Captain Wilkinson in command up to June 1957

1956 (July): Commander William R. Anderson, transferred from the submarine base at New London, to Admiral Hyman G. Rickover's Naval Reactor Branch, Washington

1957 (April): First refuelling after cruising 62,559 nautical miles of which 36,498 were done submerged

1957 (June): Commander W. R. Anderson takes command of ship at the submarine base Seattle, Washington

1957: Cruising in the Pacific Ocean

Trans-polar voyage from the Pacific to the Atlantic receives serious consideration

1958 (June 8): "Nautilus" at Seattle. Commander Anderson receives instruction to proceed from Puget Sound, near Seattle, to Portland, England, via the Arctic ice pack

1958 (July 23): Left Pearl Harbour

1958 (July 29): Bering Sea

1958 (August 1): Point Barrow, Alaska, sea valley gateway to the Arctic Ocean basin. Submerged in deep water

1958 (August 2): Latitude 76° 22' North

1958 (August 3): Latitude 87° North

1958 (August 3): 90° North (11.15 p.m.)

1958 (August 5): Surfaced in Greenland Sea

1958 (August 6): Island of Jan Mayen (71° 0' N., 9° 50' E.), Atlantic Ocean; first land seen since submerging at Point Barrow (71° 10' N., 155° 0' W.) on August 1, i.e. after five days

1958 (August 7): Passed U.S. Navy's third nuclear-powered submarine "Skate", commissioned on January 31, 1958. Its displacement when submerged is 2861 tons whilst that of the "Nautilus" is 3747 tons. The "Skate" was heading north from the Atlantic to the Pacific Ocean via the Pole, i.e. in a reverse direction to the voyage completed successfully by the "Nautilus"

1958 (August 12): Arrived at Portland, England (50° 32' N., 2° 28' E.).

4. Summary of achievements of the "Nautilus"

1. On her first fuel of enriched uranium of about 8 lb she cruised 62,559 nautical miles of which 36,498 were done submerged. This was during a period of 26 months. The burn-up of enriched uranium was 2.8 lb.

2. During "Operation Sunshine" from Pearl Harbour to Portland via the Bering Straits and under the North Pole the "Nautilus" covered a distance of 8146 miles at an average submerged speed of 17 knots in 19 days; 93% was done under water.

3. On her voyage to and from the North Pole she remained under the ice-pack for 96 hr, covering a distance of 1830 miles travelling at a depth of 400 ft or more and at a speed of 19 knots.

4. Up to August, 1958, the "Nautilus" had done 129,000 miles of which 91,000 miles were submerged.

5. On leaving Portland she crossed the Atlantic submerged to her home port, New London, Connecticut.

6. For these achievements Commander W. R. Anderson received U.S. highest award, the Legion of Merit, from the President on August 9, 1958.

5. Nuclear-powered vessels of the United States Navy in commission and under construction up to 1961

The successes of the "Nautilus" have encouraged the U.S. Navy to go ahead with the construction of nuclear-powered vessels, and by the end of 1961 a total of 26 vessels, of which 13 are submarines, are scheduled for commissioning. The essential particulars are summarized in Table I. The nomenclature and the number of each class of vessel is indicated in Table II, while the shipbuilders and the abbreviations are listed in Table III. All these vessels will have the pressurized light water cooled and moderated reactor. The submarine "Seawolf" SS(N)575 (see item 2, Table I), which had originally a sodium cooled reactor is also to have a pressurized light water reactor, which is now the accepted standard. The special features of a number of these nuclear-powered vessels are given below.

6. "Seawolf" SS(N) 575

This is the second nuclear-powered submarine to be commissioned, about two years after the "Nautilus".

Her displacement submerged is 4110 tons, about 10% larger than the "Nautilus", and the shaft horse power is 15,000. As stated above a sodium cooled reactor was installed as an alternative to the pressurized light water reactor. In the experimental stages and also during the dockside trials, leaks developed in the steam superheater system. As sodium is chemically a very dangerous substance and highly corrosive such leaks proved to be serious. As a result of further trials the "Seawolf" was accepted for restricted service. At the same time it was decided to replace the sodium cooled reactor by one using pressurized light water, similar to the "Nautilus" type. This decision was made about November 1957. Nevertheless her service and performance records are outstanding:

(a) On August 7, 1958, she submerged with a crew of 116 and after 60 days came to the surface 15 miles off Long Island Sound on October 6, 1958

(b) She had travelled more than 15,700 nautical miles under water in 60 days

(c) "Seawolf's" record of 60 days is nearly twice as long as the previous 31 days, 5½ hours set by the third nuclear-powered submarine "Skate" in May, 1958

(d) She cruised 71,609 nautical miles on her first nuclear charge.

The "Seawolf" was taken out of service on December 13, 1958, in order to replace the reactor. She is expected to be in service in a year's time.

7. "Skate" SS(N) 578

This is the third nuclear-powered submarine of the U.S. Navy. Her displacement when submerged is 2861 tons, about 23.5% less than the "Nautilus". She was completed on January 31, 1958, i.e. about three years after the "Nautilus". Further details are indicated in Table I, item 3. The "Skate's" record of under-water performance has been most remarkable for:

(a) She was the second submarine to cross the North Pole, cruising in the opposite direction to the "Nautilus".

(b) On August 15, 1958, on her return from the North Pole she visited a floating ice island,

Table I.—NUCLEAR-POWERED VESSELS OF THE U.S. NAVY IN COMMISSION AND UNDER

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|------|--------------|----------|----------------|-----------|----------|-----------|--------------|--------------------|-----------|----------------------|------|---------|-------------------|-------------------|---------|-----------|
| Item | Nomenclature | Hull No. | Name of vessel | Date | | | Displacement | | | Dimensions of vessel | | | No. of propellers | Shaft horse power | Speed | |
| | | | | Keel laid | Launched | Completed | Light | Standard (surface) | Submerged | Length | Beam | Draught | | | Surface | Submerged |
| 1 | SS(N) | 571 | Nautilus | 14.6.52 | 21.1.54 | 22.4.55 | 2975 | 3200 | 3747 | 323½ | 27 | 22 | 2 | shp | kn | kn |
| 2 | " | 575 | Seawolf | 15.9.53 | 21.7.55 | 30.3.57 | 3260 | 3495 | 4110 | 338½ | 27 | 21½ | 2 | 15000 | 18.8 | over 20 |
| 3 | " | 578 | Skate | 21.7.55 | 16.5.57 | 31.1.58 | 2190 | 2360 | 2861 | 268 | 25 | 20½ | 2 | " | 15 | 19 |
| 4 | " | 579 | Swordfish | 25.7.55 | 30.7.57 | 1.10.58 | " | " | " | 267½ | 25 | 20½ | 2 | " | 15 | 18 |
| 5 | " | 583 | Sargo | 21.2.56 | 10.10.57 | 10.10.58 | " | " | " | 267½ | 25 | 20½ | 2 | " | " | " |
| 6 | " | 584 | Seadragon | 20.6.56 | 16.8.58 | 1.12.59 | " | " | " | 268 | " | " | 2 | " | " | " |
| 7 | " | 585 | Skipjack | 29.5.56 | 26.5.58 | 19.12.58 | 2310 | 2850 | 3000 | 252 | 31 | " | 1 | " | " | over 20 |
| 8 | " | 588 | Scamp | " | " | " | " | " | " | " | " | " | 1 | " | " | " |
| 9 | " | 589 | Scorpion | 1.8.58 | " | " | " | " | " | " | " | " | 1 | " | " | " |
| 10 | " | 590 | Sculpin | 3.2.58 | 31.7.59 | 27.5.60 | " | " | " | " | " | " | 1 | " | " | " |
| 11 | " | 591 | Shark | 24.2.58 | 4.12.59 | 30.9.60 | 2830 | " | " | 252 | " | " | 1 | " | " | " |
| 12 | " | 592 | Snook | 7.4.58 | 15.1.60 | 15.11.60 | " | " | " | " | " | " | 1 | " | " | " |
| 13 | " | 593 | Thresher | " | " | " | 3000 | 3250 | " | 274 | " | " | 1 | " | " | " |
| 14 | SSR(N) | 586 | Triton | 29.5.56 | 19.8.58 | 19.5.59 | 5650 | 5900 | 8000 | 447 | 37 | 25 | 2 | " | " | 30 |
| 15 | SSG(N) | 587 | Halibut | 11.4.57 | 15.12.58 | 1.12.59 | 2900 | 3555 | " | 350 | 29 | " | 1 | " | " | " |
| 16 | " | 594 | Permit | " | " | 1961 | 4175 | 4240 | " | 373 | 33 | " | 1 | " | " | " |
| 17 | " | 595 | Pollock | " | " | " | " | " | " | " | " | " | 1 | " | " | " |
| 18 | " | 596 | Plunger | " | " | " | " | " | " | " | " | " | 1 | " | " | " |
| 19 | SSB(N) | 598 | " | May, 58 | May, 59 | " | 5400 | 5600 | " | 380 | 33 | " | 2 | " | " | " |
| 20 | " | 599 | " | June, 58 | July, 59 | " | " | " | " | " | " | " | 2 | " | " | " |
| 21 | " | 600 | " | June, 58 | Aug., 59 | " | " | " | " | " | " | " | 2 | " | " | " |
| 22 | SSK(N) | 597 | Tullibee | 26.5.58 | " | " | 2000 | 2175 | 2490 | 260 | " | " | 1 | " | " | " |
| 23 | DD(N) | " | " | Dec., 57 | " | " | 3000 | " | " | 420 | 46 | 20 | 2 | " | 50 | " |
| 24 | DLG(N) | " | " | " | " | " | 5000 | 7600 | " | 550 | 56 | 20 | 2 | " | " | " |
| 25 | CG(N) | 9 | Long Beach | 2.12.57 | " | 1961 | 11000 | 14000 | " | 721 | 73 | 26 | 2 | " | 45 | " |
| 26 | CVA(N) | 65 | Enterprise | 4.2.58 | June, 60 | Sept., 61 | 75700 | 85000 | " | 1100 | 133 | 37 | 4 | 300000 | 35 | " |

about 300 miles south of the North Pole, known as Alpha and used by the International Geophysical Year Scientists.

- (c) On March 17, 1959, during her second voyage under the Arctic ice pack, the "Skate" scattered the ashes of Sir Hubert Wilkins.
- (d) At the end of March the "Skate" crossed the Atlantic from Great Britain to New London, Connecticut, U.S.A., in 8 days 11 hours.
- (e) On April 7, 1959, the "Skate" returned to Groton (Conn.) after a second voyage under the North Pole, a distance of 3,090 miles.

8. "Swordfish", "Sargo" and "Seadragon", SS(N) 579, SS(N) 583, SS(N) 584

These three submarines belong to the "Skate" class. Their completion dates were:

- "Swordfish", October 1, 1958
- "Sargo", October 10, 1958
- "Seadragon", December 1, 1958.

9. "Skipjack", SS(N) 585

This submarine has a submerged displacement of 3000 tons, about 4.5% larger than the "Skate" class. Other essential particulars are contained in Table I, item 7. It has been specially designed for a maximum underwater performance and the power plant incorporates the advances in design based on improved pressurized light water reactor technology. On April 12, 1959, the "Skipjack" returned to its base at Groton, Connecticut, after a successful trial run, Vice-Admiral Rickover being in charge. The speed has so far not been divulged, but it would appear to be not less than 30 knots. The "Skipjack's" hull is based on that of the "Albacore", which is whale-shaped. She was commissioned on April 15, 1959.

Before considering other U.S. nuclear-powered vessels it may be mentioned at this stage that in March, 1959, the United States agreed to supply a nuclear propulsion plant of the "Skipjack"-type for the British nuclear submarine "Dreadnought". This necessitated modifying the hull of the latter to accommodate the reactor, which is to be installed in about two years. The keel of the "Dreadnought" was laid in June of this year. Commander

CONSTRUCTION UP TO 1961

| 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---------|------|-------|------------|-----|-------|---------|---------|-------------------|-------|
| Reactor | | | Complement | | | Builder | | | |
| No. | Type | Range | Officers | Men | Total | Builder | Reactor | Main turbine cost | Total |
| | | miles | | | | | | | \$m |
| 1 | PWR | 40000 | 12 | 89 | 101 | EBD | WE | WE | |
| 1 | SCR | 70000 | | | 94 | | GE | GE | |
| 1 | PWR | | 9 | 86 | 95 | | WE | WE | |
| 1 | " | | | | 83 | PNY | " | " | |
| 1 | " | | | | 83 | MINY | " | " | |
| 1 | " | | | | 83 | PNY | " | " | |
| 1 | " | 60000 | | | | EBD | " | " | |
| 1 | " | | | | | MINY | | | |
| 1 | " | | | | | ISB | | | |
| 1 | " | | | | | NNSY | GE | | |
| 1 | " | | | | | ISB | | | |
| 1 | " | | | | | PNY | | | |
| 2 | " | | | | 148 | EBD | | | |
| 1 | " | | | | | MINY | | | |
| 1 | " | | | | | PNY | | | |
| 2 | " | | 10 | 90 | 100 | EBD | WE | | 296 |
| 2 | " | | " | " | " | " | " | " | |
| 2 | " | | " | " | " | MINY | " | " | |
| 1 | " | | | | | EBD | | | |
| 2 | " | | | | 450 | BSC | | | |
| 2 | " | | | | | BSC | WE | GE | 88 |
| 8 | " | | | | | NNSY | " | WE | 314 |

B. Samborne, R.N., who will be in command, is spending six months in the "Skipjack" gaining operating experience on the nuclear power plant.

Table II.—NOMENCLATURE AND NUMBER OF NUCLEAR-POWERED VESSELS OF THE UNITED STATES NAVY

| Type | Nomenclature | Number of vessels |
|---|--------------|-------------------|
| 1. Nuclear-powered submarine | SS(N) | 13 |
| 2. Nuclear-powered radar picket submarine | SSR(N) | 1 |
| 3. Nuclear-powered guided missile attack submarine | SSG(N) | 4 |
| 4. Nuclear-powered fleet ballistic missile submarine | SSB(N) | 3 |
| 5. Nuclear-powered hunter-killer submarine (anti-submarine) | SSK(N) | 1 |
| 6. Nuclear-powered destroyer | DD(N) | 1 |
| 7. Nuclear-powered guided missile destroyer leader | DLG(N) | 1 |
| 8. Nuclear-powered guided missile cruiser | CG(N) | 1 |
| 9. Nuclear-powered attack aircraft carrier | CVA(N) | 1 |

Table III.—SHIPBUILDERS OF THE NUCLEAR-POWERED VESSELS OF THE UNITED STATES NAVY

| Shipbuilder | Abbreviation |
|--|--------------|
| 1. Electric Boat Division of the General Dynamics Corporation, Groton, Connecticut | EBD |
| 2. Newport News Shipbuilding Yard, Virginia | NNSY |
| 3. Mare Island Naval Yard, California | MINY |
| 4. Portsmouth Naval Shipyard, New Hampshire | PNY |
| 5. Ingalls S.B., Pascagoula, Mississippi | ISB |
| 6. Bethlehem Steel Co., Quincy, Massachusetts | BSC |

Table IV.—A SUMMARY OF THE ESSENTIAL DESIGN DATA AND THE PRINCIPAL PARTICULARS OF THE N.S. SAVANNAH

| | |
|--|-----------------------|
| 1. Vessel | |
| (a) overall length | 595 ft 6 in. |
| (b) beam | 78 ft 0 in. |
| (c) draught | 29 ft 6 in. |
| (d) total displacement | 21840 ton |
| (e) cargo deadweight | 9400 ton |
| (f) number of passengers | 60 to 100 |
| (g) normal power at propeller shaft | 20000 shp |
| (h) maximum power at propeller shaft | 22000 shp |
| (i) normal speed | 20-25 kn |
| (j) number of propellers | 1 |
| (k) speed of the propeller | 110 rpm |
| (l) cruising period per fuel charge at normal power | 730 days |
| (m) auxiliary turbo-generators | 2 at 1500 kW |
| (n) stand-by diesel-generators | 2 at 750kW |
| (o) emergency diesel-generator | 1 at 300kW |
| 2. Reactor | |
| (a) number of reactors | 1 |
| (b) type | PWR |
| (c) normal heat rating | 63 MW |
| (d) maximum heat rating | 74 MW |
| (e) pressure of cooling water | 1750 psi |
| (f) primary water flow | 19800 gpm |
| (g) mean temperature of primary water | 508°F |
| (h) temperature rise of primary water | 22-5°F |
| (i) type of nuclear fuel | uranium oxide pellets |
| (j) enrichment of fuel, % of U235 | 3-6 to 4-0% |
| (k) weight of nuclear fuel | 330 kg |
| (l) diameter of core | 66 in. |
| (m) length of core | 66 in. |
| (n) number of rectangular fuel elements (8-9 in. square) | 32 |
| (o) number of fuel rods for each element | 196 |
| (p) diameter of fuel rods | 1/2 in. |
| (q) designed core life | 52200 MWD |
| 3. Reactor vessel | |
| (a) inside diameter | 98 in. |
| (b) height | 26.5 ft |
| (c) designed pressure | 2000 psi |
| (d) material | carbon steel |
| (e) inside cladding | stainless, type 304 |
| (f) the upper head, which contains the control drive, is removable for refuelling by way of a 90 in. dia closure | |
| 4. Containment vessel | |
| (a) diameter | 35 ft |
| (b) length | 50.5 ft |
| (c) designed pressure | 186 psi |
| (d) completely sealed and the ambient temperature is maintained at not greater than 120°F by an isolated air conditioning system | |
| (e) it contains the reactor, the two steam drums, pressurizer, two heat exchangers and the necessary piping | |
| 5. Main steam turbine with reduction gears | |
| (a) number of sets | one |
| (b) number of cylinders (H.P. and L.P.) | two |
| (c) moisture separator between the H.P. and L.P. cylinders | one |
| (d) pressure at turbine stop valve | 475 psia |
| (e) temperature at turbine stop valve | 462°F |
| (f) vacuum at the L.P. exhaust (30 in. Hg bar.) | 28.5 in.Hg |
| 6. Weight of machinery | |
| (a) reactor system | 600 ton |
| (b) containment vessel and shielding | 1900 ton |
| (c) propulsion system | 1150 ton |
| (d) total, (a+b+c) | 3650 ton |
| 7. Total capital cost excluding fuel, but including some for research and development (approx) | |
| (a) reactor and power plant | \$14,500,000 |
| (b) shielding and containment vessel | \$1,500,000 |
| (c) hull and outfit | \$14,500,000 |
| (d) total (a+b+c) | \$30,500,000 |

10. "Triton", SSR(N) 586

This vessel is classified as a nuclear-powered radar picket submarine. Her submerged displacement is 8000 tons, length 447 ft, beam 37 ft, and draught 25 ft. The keel was laid May 29, 1956, the launching was on August 19, 1958, and the date of completion was scheduled for May 19, 1959. This exceptionally large submarine has two reactors and two propellers, and she is claimed to be the largest submarine ever built. She is designed to keep up with the fastest aircraft carriers and destroyers: her speed would be at least 30 knots and her total complement is to be 148.

11. Nuclear-powered guided missile submarines, SSG(N). (Table I, items 15 to 18)

The first to be built in this group was the "Halibut" with a displacement of 3555 tons. The following three, the "Permit", "Pollock" and "Plunger" have displacements of 4240 tons, about 19.5% larger. Further particulars of these four submarines are given in Table I, items 15 to 18 inclusive. The vessels will handle the guided missile "Regulus II". The "Permit", "Pollock" and "Plunger" have increased power and a higher submerged speed than the "Halibut".

12. Nuclear-powered fleet ballistic missile submarine, SSB(N). (Table I, items 19, 20, 21)

There are three identical vessels under construction, the SSB(N) 598, 599 and 600, each with a displacement of 5600 tons. The length is 380 ft and the beam 33 ft. These submarines are specially designed for launching the guided missile "Polaris", which has a length of 50 ft, a diameter of 50 in., a nuclear warhead, and a range of 1200 miles. The nuclear power plant has two reactors. This new construction programme was signed on February 11, 1958, and the sum mentioned was \$296 million (£107 million). They will have the "Albacore" type of hull configuration to obtain a high underwater speed. The guided missile "Polaris" is fired with the submarine submerged, vertically from within the submarine. Additional information is given in Table I, items 19, 20 and 21. In July, 1958, another two such vessels, SSB(N) 601 and 602, were authorised for construction, and another four are receiving consideration. If sanctioned they will be SSB(N) 608 to 611 inclusive.

13. Nuclear-powered hunter-killer submarine, SSK(N). (Table I, item 22)

Only one of these, the "Tullibee", SSK(N) 597, is under construction, the submerged displacement being 2490 tons, and the length of the vessel 260 ft. So far it is the smallest nuclear submarine to be built. It is to have an "Albacore" type of hull. The keel was laid on May 26, 1958. The "Tullibee" has been specially designed for high speed and manoeuvrability.

14. Nuclear-powered destroyer, DD(N). (Table I, item 23)

The contract for the construction of one destroyer was awarded in December, 1957. It will be the smallest surface fighter ship in the world to have a nuclear power plant. The displacement will be 3000 tons, the length 420 ft, the beam 46 ft, and the draught 20 ft. There will be two propellers and the speed will be 50 knots.

15. Guided missile destroyer "Leader", DLG(N). (Table I, item 24)

This vessel is officially rated as a nuclear guided missile frigate. Only one is at present under construction. The full displacement is 7600 tons and the dimensions of the vessel are 550 ft × 56 ft × 20 ft. The guided missiles consist of two "Terrier", surface-to-air type, with twin launchers mounted fore and aft. There are also two 3-in. AA guns located amidships. The nuclear power plant has two reactors and conventional geared turbines which drive the two propellers. The complete complement is 450. She is the first nuclear-powered warship of the destroyer type ever to be built. The sums appropriated are \$35 million (£12.7 million) for the nuclear power plant, and \$10 million (£3.65 million) for preliminary work on the design and the hull. This vessel will have a much greater cruising range and higher speed than the conventionally powered frigate.

16. Nuclear-powered guided missile cruiser, CG(N) 9. (Table I, item 25)

The contracts for one of this "Long Beech" class have been awarded and the keel was laid on December 2, 1957. She is expected to be in commission in 1961. Her full load displacement is 14,000 tons. The vessel has a length of 721 ft, beam 73 ft, and draught 26 ft. Her armament will consist almost entirely of guided weapons such as the "Regulus" Mark II, a "Talos" battery aft and a "Terrier" battery forward. The nuclear power plant has two reactors and geared turbines for the two propellers. The speed is 45 knots and the total cost is estimated at \$88 million (£32 million) which includes about \$18 million (£6.55 million) for the nuclear reactors. She is designed by the Bureau of Ships and is officially scheduled for completion early in 1961.

17. Nuclear-powered attack aircraft carrier, CVA(N) 65. (Table I, item 26)

This vessel is the first of her class and is named "Enterprise". She was ordered on August 16, 1957, and the keel was laid on February 4, 1958. Her full load displacement is 85,000 tons and her dimensions are length 1100 ft, beam 133 ft, and draught 37 ft. The guided missiles consist of "Terrier" batteries located at each quadrant. The power plant has eight reactors and the four propellers require a total of 300,000 shp at a maximum speed of 35 knots. The total cost of this first nuclear-powered aircraft carrier is \$314 million (about £114 million). The "Enterprise" will be launched in June, 1960, and completed in September, 1961. The nuclear propulsion plant was designed and developed by the Atomic Energy Commission. The Westinghouse Electric Corporation were awarded the contract for the power plant and the steam turbines, with reduction gears for the four propellers, on December 17, 1957.

It was the intention to build six nuclear-powered carriers of this class to bring the number of attack aircraft carriers up to U.S. Navy's operational requirement of a minimum of fifteen.

The foregoing concise review demonstrates the remarkable developments in nuclear marine propulsion of the U.S. Navy. No country in the world is in position to boast of such up-to-date naval strength. By the end of 1961 she will have a nuclear-powered fleet consisting of at least 33 submarines, one destroyer, one guided missile destroyer, one guided missile cruiser and one attack aircraft carrier. A further extension to this nuclear powered naval programme is receiving con-

sideration. By 1965 the fleet may have increased to twice its size.

Careful pre-planning, expert technical advice and particularly wide experience in design and manufacture have been responsible for the rapid advances which have proved so successful and most encouraging. The unique operating experience of such intricate nuclear plants is undoubtedly of inestimable value. Unfortunately, for security reasons, no detailed information on the design data of the reactors and the main propulsion turbines has so far been published.

18. N.S.S. "Savannah"

This is the first merchant ship in the world to be equipped with nuclear propulsion plant. It is under construction at Camden, New Jersey, and the vessel is expected to be ready for commissioning in 1960. The pressurized light water moderated and cooled reactor, utilizing low enriched fuel, has a maximum thermal output of 74 MW. In addition to the 22,000 shp, transmitted to a single propeller, it also supplies the ship's total services. She was launched on July 21, 1959, and at approximately \$40 million (£14.5 million) cost nearly double that of a conventional merchant vessel of the same size and speed. The slightly enriched uranium fuel will last for three years and will enable her to do about 300,000 miles.

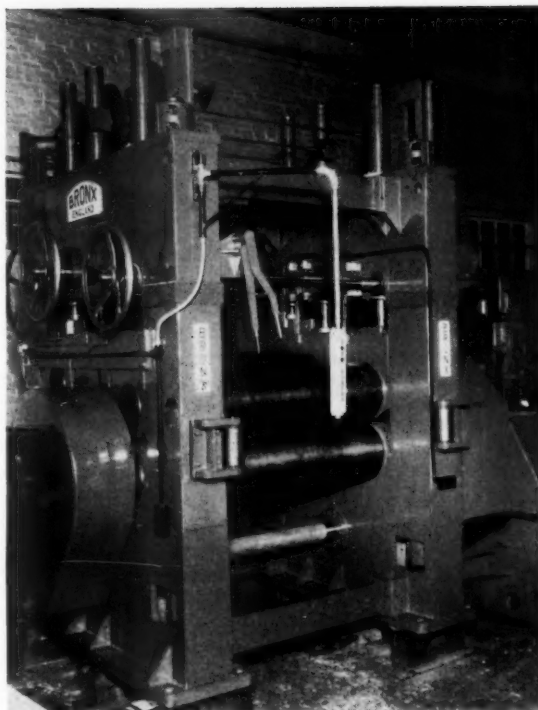
Levelling and Straightening Heavy Plate

A machine for levelling and straightening mild steel plate and equivalent high tensile plates in sizes from 5 ft by 2 in. to 1 ft by 4 in. has been designed and built by The Bronx Engineering Company Limited, of Lye, near Stourbridge. As will be seen from the accompanying general view the machine has six rolls consisting of a pair of pinch rolls and four levelling rolls. The body length of the rolls is 5 ft 4 in. and the diameter of the pinch rolls 17 in. The bottom rolls are 17 in. dia, the top centre roll 19 in. and the outgoing top roll 15 in.

The arrangement of the rolls is such that the operator has complete control over the plate in its passage through the machine. The upper pinch roll and two upper levelling rolls are each separately adjustable by means of three 10 hp motors. Large indicator dials clearly show the position of each roll and roll adjustments are made only when the plate is not in contact with the rolls. Large diameter double handwheels are provided for all top rolls by means of which the operator can, if required, tilt these rolls to assist in taking out edge camber. This tilting action can be used in conjunction with or without the use of shim plates at the discretion of the operator. The handwheels can be used to give a fine adjustment to the position of the top rolls as required. Shear pins mounted in hardened and ground bushes are fitted to the pinch roll chocks.

The machine and control gear is arranged for reverse levelling under full load conditions but the normal entry side is at the pinch roll end and the outgoing top roll controls the final sweep of the plate whether up, down or in a level plane.

The drive is taken from a reversing 80 hp motor with magnetic brake, through a double reduction totally enclosed gear box, and thence by double helical gearing to the three lower rolls to give a levelling speed of



Bronx levelling and straightening machine

approximately 15 ft per min. The phosphor bronze roll neck bearings are automatically lubricated from a motorised oil pump and oil is fed to the final double helical roll gearing.

In-production Cleaning of Machine Tool Sump Oil

A new sump cleaning and filtering unit has been introduced by Industrial Vac-Air Limited of 30 Highbury Place, London, N5. The machine is expressly designed for removing foreign matter from machine tool sumps. In one operation a sump can be emptied and cleaned and the coolant filtered and returned to the sump, leaving the dry sludge and other dirt deposited in the filter chamber from which it is easily removed for subsequent disposal or salvage. It is possible to remove 95% of the sludge from a machine without hindering production. Its powerful suction is provided by two 1½ hp ac/dc units made by Martindale Electric Company Limited.

Capacities range from 50 to 200 gal. Sump oils can be dealt with at 1200 gph and the clean oil replaced at 1,000 gph against a head of 20 ft.

The twin suction units are remotely controlled and an automatic cut-out prevents overloading and overfilling. The pumping unit is similarly protected.

The filter unit is a perforated steel container surrounded with a nylon mesh. Its sludge capacity is 1½ cu ft.

The cleaner and filter unit costs £285 if fitted with Martindale's Cyclone motors and £305 when fitted with the more powerful Martindale Typhoon motors.

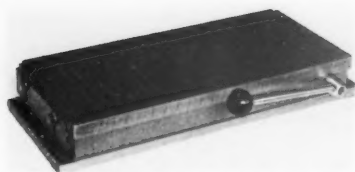


Fig. 1.—The D-type chuck is of low overall height

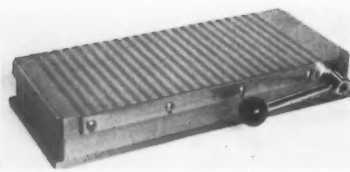


Fig. 2.—In the F-type the magnetic elements are continued right across the face of the chuck

Magnetic Chucks and Adaptors

A comprehensive range of permanent magnet chucks and accessories is now being marketed by Darwins Limited, Tinsley, Sheffield, under the name "Fimax". The range comprises two rectangular chucks, a universal chuck, a rotary sine angle chuck, and adaptor blocks.

The rectangular chucks are a D-type designed and manufactured by Darwins Limited, and an F-type designed by Messrs. Panton and Webb and for which Darwins have sole rights of manufacture and sale. The D-type (Fig. 1) has low overall height and close pole spacing to enable small work to be held without having to use adaptors. The F-type (Fig. 2) has the magnetic elements continued right across the face of the chuck thus permitting work to be held on the side of the chuck when required, and also allowing chucks to be ganged together, for which purpose the whole gang is operated by one lever. Incidentally, the lever spindle is extensible to clear outside work-pieces.

The universal chuck (Fig. 3) has a Type F chuck mounted on a cast iron universal head having two faces at right angles for alternative mounting, and two axes at right angles with graduated scales, and also a lever for clamping. This chuck is used most elegantly by placing it on a rectangular magnetic chuck on the machine table. There is then complete control over position and setting. The chuck is supplied in a lined hardwood cabinet.

The rotary sine angle chuck (Fig. 4) has a 14 × 12 in. type-F magnetic chuck mounted so that it tilts about one lower corner. It is also arranged to rotate about a vertical axis. The tilting is controlled by a screw-operated link motion. The chuck body with its trunnion and two sine rollers form a 10 in. sine bar so that angles can be set accurately about

the horizontal axis. Two piles of slip gauges are used, one on each side of the chuck, and they are nipped in position by the link motion, an arrangement which ensures rigidity under heavy load. The 14 × 12 in. chuck is very powerful, having four separate magnetic packs and full length ribs. Rotation about the vertical axis on the swivel base is on a wide flat surface with a large diameter spigot. Setting is normally by the large degree scale, but for a high degree of accuracy a 10 in. sine bar may be attached by means of a special bracket.

The adaptor blocks are a plain rectangular and a tilting pattern. They both conduct the magnetic flux from the chuck face to the work piece. The tilting block is in two parts with the mating surface on the arc of a circle so that one may rotate on the other. A scale is provided for setting the two at the desired angle. The blocks are supplied in lined cases.

Air Valves, Cylinders and Equipment

Two new patterns of air control valve, two new blow guns and a new range of air cylinders have been introduced by Air Automation, 26 Sharrocks Street, Wolverhampton.

Two of the valves are of the piston type and as the only wearing component is the piston, apart from the static seals (there are no moving seals), the valves are easily serviced without removing the body from the air line. By the use of standardised end fittings, the one standard body forms the basis of all the variations in type, and the change from "pilot operated both ways" to "hand lever operation" or "spring return", involves only the interchange of end fittings secured by a common retaining flange and by four cap screws or studs and nuts. The valves are made in $\frac{1}{4}$ in. and $\frac{3}{8}$ in. B.S.P. sizes.



Fig. 3.—F type chuck mounted on a universal head

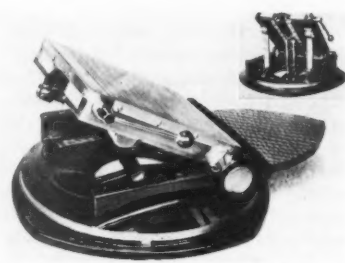


Fig. 4.—Rotary sine angle magnetic chuck

The other new valves embody a new system of diaphragm poppet actuation which is the subject of a patent application. Sealing is effected by neoprene diaphragms and gaskets and does not rely on close tolerances, metal to metal seatings, or on O-rings, and maintenance involves only the loosening of four screws and replacement of the neoprene elements, without disconnecting the valve body from the air-line. The valves consist of a base block and a head block, and as a result of standardisation a large number of the base blocks are identical and the actuation of the valve can be altered (e.g., from roller to hand lever), by changing the head block only. In the case of the 3-way valves, the top block can be fixed at 90° (either way) or at 180° to the



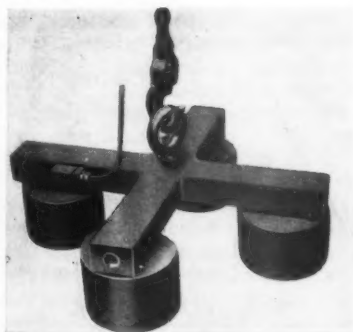
Airmatic poppet valve

base block by simply loosening the four securing screws and rotating the block. This gives a useful variety of positions of actuating mechanism or pilot port in relation to fixing holes and inlet port. The valve stems, diaphragms, etc., in both 3-way and 4-way types, are for a given size ($\frac{1}{8}$ in. or $\frac{1}{4}$ in. B.S.P.) identical, so that there is no difficulty with regard to variety of spare parts.

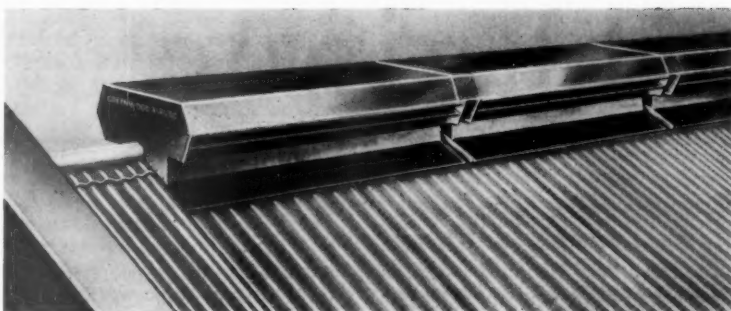
The two new patterns of compressed air blow guns both incorporate a balanced hanging hook to obviate the damage caused by dropping a blow gun between periods of use. The body is a brass hot pressing either with press button blast control or with a trigger actuation to give control of air from a gentle puff to a full blast. Prices are as low as 8/6d. for the press button model.

The company's new "Airmatic" cylinders can all be used directly for foot, nose, front trunnion, and rear trunnion mounting, and by the use of longer tie bars it is also possible to flange mount. In consequence spare standard cylinders can be used for any application within their stroke and power capacity. The materials are non-corrosive. The end caps of the smallest models are of gun metal and in the larger sizes of high grade cast iron with non-ferrous bushes for cushion bores. The main piston carries synthetic rubber cap seals, the use of O-rings being confined to some of the cushioning seals.

The company also report a complete range of non-ferrous air line fittings. B.S.P. threads are used throughout and the solderless fittings can be used both for copper and nylon tubing without modification.



New Clover leaf lifting magnet



The Greenwood-Airvac Ridgeline air extractor

Natural Ventilation of Industrial Buildings

Designed to give permanent or controlled natural ventilation in all types of industrial buildings, the new Greenwood-Airvac Ridgeline is a ridge-mounted extractor with a large outlet area and aerodynamic design to give maximum extraction based on stack action for the effective removal of vitiated air fumes rising naturally towards the roof ridge. An overall cover and internal baffles provide weather protection without restriction.

Rising only 9 in. above the ridge of the roof, the Ridgeline has neat and unobtrusive appearance and blends well with modern building design. Made to fit all standard forms of roofing, the Ridgeline can be installed either as a single unit (SU) for short lengths (3 ft 10 in. or 5 ft 10 in.) or as a combination of two end terminal units (ETU), with or without one or more intermediate units (IU) for longer lengths. It is made of hardened aluminium having high anti-corrosive and long lasting qualities.

Manually controlled or thermostatically operated motorised dampers are provided where conservation of heat in winter is of special importance. These dampers are designed to avoid restriction of the airflow when the extractor is in the fully opened position. The ventilator is made by Greenwood's and Airvac Ventilating Company Limited, Beacon House, Kingsway, London, WC2.

Clover Leaf Magnet

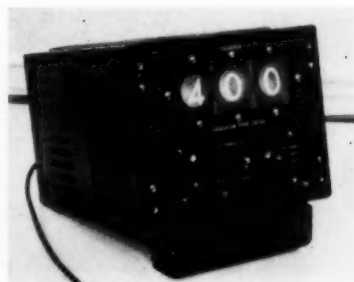
This new lifting magnet is to facilitate the handling of coiled mild steel strip and the like. It consists of a number of magnets mounted on a common framework, and adjustable

to cover various coil diameters, thus avoiding the need for large diameter magnets to cover a wide range of coils.—Rapid Magnetic Machines Limited, Lombard Street, Birmingham.

Industrial Digital Voltmeter

Almost every physical quantity can now be converted electronically into an electrical voltage. To read-off these voltages to three-figure accuracy with certainty the Solartron Electronic Group Limited, Thames Ditton, Surrey, have produced the Solartron "999" digital voltmeter Type LM 901 which displays the measured voltage in large, plain figures, which may be read at considerable distance from the instrument.

The instrument may be used independently or as a module in large installations. The voltage range is from zero up to 99.9V in three sub-ranges, or 109.9V when using the range extension facility. The measured voltage is continuously monitored and the readings change with any variation. Alternatively, varying voltages may be periodically measured by turning a switch and pressing a "sampling" button when a new reading is required. The figures then remain at the last reading until the push-button is pressed again.



The Solartron 999 digital voltmeter

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their own experience in matters relating to
design, manufacture and maintenance

Processing Reinforcing Bars for Pre-stressed Concrete

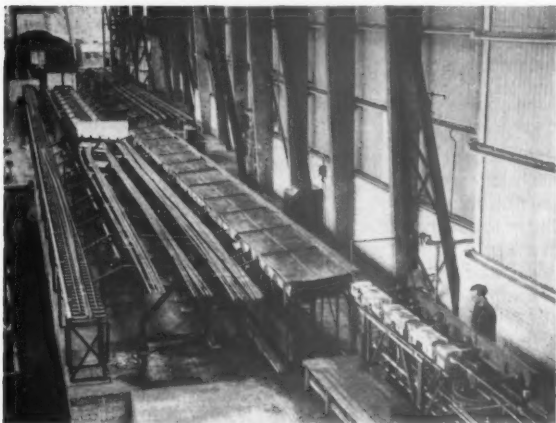
Rolled steel bars used in pre-stressed reinforced concrete require accelerated ageing and stress relieving and preparation of the ends for coupling or anchorage. Ten years ago McCall Macalloy Limited set up a pilot plant in Sheffield for investigating this work on a production basis and as a result of experience gained, have now completed a line production system which provides a continuous mechanically handled process. Re-

increased with a corresponding increase in allowable working stress from 42 to 45 tons per sq in. Rolled-threaded bars provide for a tolerance of ± 2 in. on the length of concrete unit, since the efficiency of the anchorage is independent of the finishing position of the nut. Setting-up and stressing the bars is thus greatly simplified.

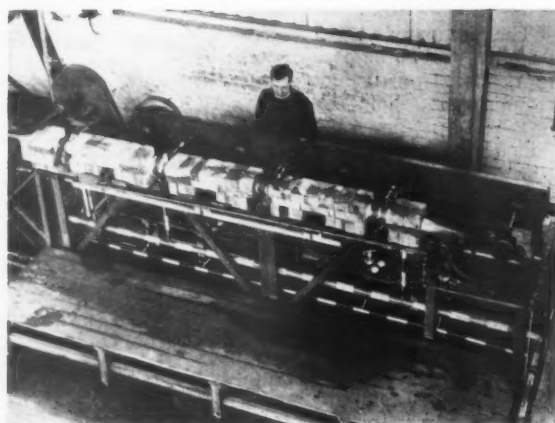
New high tensile steel couplers, of reduced size and one-quarter of the

An alternative wedge anchor, for all diameters of bar, is provided for use where tolerances greater than those afforded by the rolled thread may be required, as, for example, in the transverse pre-stressing of bridge decks. The wedge also provides a smaller projection beyond the end of the concrete than the corresponding nut and washer.

For embedded anchorages, cast iron tubular sleeve anchorages or threaded end plate are available. The former are used in conjunction with a $\frac{1}{4}$ in. dia mild steel helical



Macalloy plant seen from the furnace end. Furnace is in foreground, covered cooling chamber beyond, and stretching bed in background



Propane-oxygen gas fired heat-treatment furnace. Bars enter from right and pass into cooling chamber to left

search and development have also proceeded on the improvement and extension of the range of anchorages and stressing equipment.

Rolled threads with N.U.F. form and pitch replace the cut thread hitherto used with the Lee-McCall high efficiency nuts. The effective diameter of the thread has been

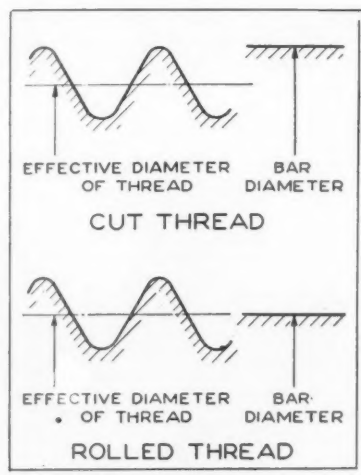
weight of the previous standard couplers have been developed in conjunction with the rolled thread on the bars. The area of duct required to accommodate coupled bars will be much reduced and in most cases it will be unnecessary to provide for any enlargement of the ducts at points where couplers occur.



Close-up of one of the heating elements of the furnace with bricks removed to show bar and flame



Showing small size of new coupler (left) compared with the old one



Relation of effective diameter to as-rolled bar diameter for both cut and rolled threads

binding to contain the bursting stresses in the concrete and may also be used in relatively thin concrete sections. Nuts and washers are dispensed with in the case of the threaded end plate.

The Lee-McCall jacks have been redesigned to stress bars with threaded or wedge anchorages. For this purpose the thrust legs are inter-

changeable with the secondary jack required to drive home the wedges. The jack barrels, hydraulic pumps, carriage and other equipment are standard and the new pattern will supersede the marks I to III jacks at present in use. The 1½ in. dia bar with its initial load of 55 tons requires a larger, 60-ton capacity jack which is similar in all respects to the standard 45-ton jack.

Consumable Electrode Inert Gas Welding

Consumable electrode (M.I.G.) welding has for some time been recognised as having special advantages in the welding of aluminium alloy material over $\frac{1}{16}$ in. thick; high speeds and deep penetration are obtained and the spray transfer of metal across the arc allows welding in all positions to be carried out. However, the smallest diameter filler wire that can easily be fed is $\frac{3}{64}$ in., and since the thickness of material that can be welded depends partly upon the thickness of the wire being used, material thinner than $\frac{1}{16}$ in. is generally welded by the argon-arc process rather than by this method.

Northern Aluminium Company Limited, in conjunction with Aluminium Laboratories Limited, have carried out tests and development work on a new system of M.I.G. welding using self-feeding guns that themselves carry a small spool of wire, instead of a larger spool being located some distance away. This means that the wire, instead of being pushed through distances of perhaps 10 ft, has only to be pushed about 3 in., and consequently a much thinner wire can be used. This fine-wire welding system has been successfully used in America for about four years and one American gun, together with the attendant electrical equipment, is now being marketed in this country by Rowen-Arc (Division of Rubery Owen and Company Limited), Longford, Coventry, under the name "Rowen-Gun". This can feed wires down to 0.020 in. dia and so will extend the useful range of M.I.G. welding to materials as thin as 0.036 in. As well as being able to weld thin material at high speeds, the gun has the considerable advantages of portability (it weighs only 4 lb including the spool of wire) and easy handling, which makes welding easier in positions to which access is



Fine wire welding with the self-feeding 'Rowen-Gun'

difficult for conventional consumable electrode equipment.

Pre-treatment Methods in Hoover Factories

The objects of pre-treatment are to hold back rust and corrosion and to give a surface to which enamel can firmly adhere. Three different pre-treatment methods are used at the Hoover Merthyr factory and at the sister factory at Aberdare, seven miles away. Steel parts are given a phosphate coat with I.C.I. Granodine preparation. The treatment of aluminium parts is by either Alocrom—also an I.C.I. chemical—or by anodizing.

The effect of Granodizing is to crystallize and slightly roughen the surface of steel parts by conversion into a non-metallic phosphate. Anodizing is an artificial thickening of the natural aluminium oxide layer and Alocroming gives surfaces a protective oxy-chromate film.

Phosphating is not aimed at offering protection against scratching, but after enamelling, if the phosphate coat is penetrated, corrosion beyond

the uncovered area is effectively retarded. Anodizing, because it hardens aluminium surfaces, results in sound protection against normal scratching hazards as well as a defence against corrosion. Alocrom is used on aluminium castings where it is more suitable than anodizing.

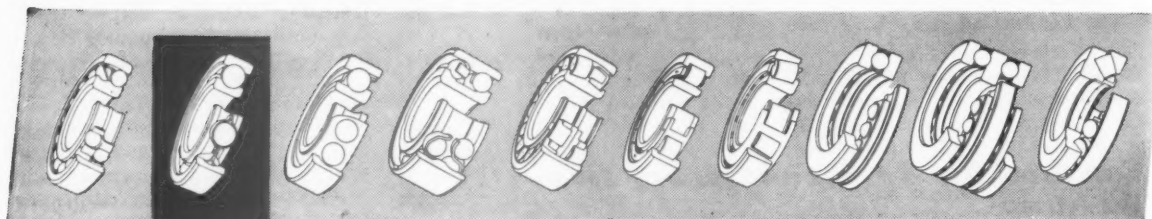
The phosphating plants at Merthyr are fully automatic. One deals with Hoovermatic components, the other with washing machine and Spina-rinse parts. First stage is the cleaning of the parts by a spray, a dip and a second spray in an alkaline solution. Then there are two rinses in hot water with a period for draining before and after these. Next comes immersion in a tank of Granodine solution, followed by another hot water rinse and draining period. To neutralize the effects of hard water salts still clinging to surfaces, the parts are then dipped in a tank of dilute chromic acid, drained and finally dried by convection. The whole process goes on in a steel tunnel containing a series of tanks. It takes about 20 min after which the parts are brushed to remove surface powder deposits. They are then ready for enamelling.

The anodizing process follows a similar sequence of events. Parts are first cleaned and etched in caustic soda. Next they are rinsed in cold water, then put through a weak hydrofluoric acid solution further to clean and etch the surfaces. After another cold water rinse, they pass through the anodizing bath, which contains dilute sulphuric acid. In this bath, electric current is sent through the acid and the immersed components. Rinses in three separate cold water baths follow, and then the final phase of "sealing" in boiling water.

Dryer lids get additional treatment: after dipping in caustic soda and hydrofluoric acid, they are immersed in an acidic brightening solution and, before sealing, coloured blue by a dip in warm dye.

The Aberdare Alocroming plant is automatic. There, aluminium castings, mainly for wringers, are first degreased in a tank of trichlorethylene. Cooled naturally in air, they are immersed in Alocrom solution, rinsed in cold water and then in warm Deoxylite. The process ends with controlled oven-drying.

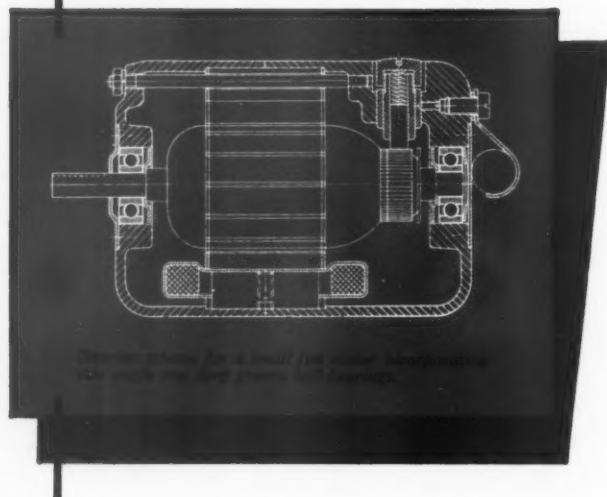
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Trawsfynydd Nuclear Power Station

Situated within the North Wales National Park the Trawsfynydd nuclear power station will be a test of architectural ability in suiting massive construction to rural surroundings. Preliminary technical details of the plant are given in full below

THE nuclear power station which Atomic Power Constructors Limited are to build at Trawsfynydd in North Wales provides for two natural uranium, graphite moderated, gas cooled reactors which operate in conjunction with turbo-alternator plant to give a net station output of 500 MW.

The graphite moderator structure will be approximately 48 ft across flats and 27 ft 6 in. high, and contain 3720 vertical fuel element channels on a square lattice pitch of $7\frac{1}{2}$ in. The moderator structure will be made up from a large number of machined graphite blocks held together by circumferential restraint members.

The vertical fuel element channels will contain fuel elements of natural uranium sheathed in a magnesium alloy can. This can will have an extended surface to give improved heat transfer and four longitudinal alloy splitters to centralize the element in the channel.

The diameter of the fuel element channel will be constant throughout the core. The channels outside the flattened zone of the reactor will be gagged to ensure that heat is removed at the highest outlet gas temperature.

The graphite moderator structure will be supported from a fabricated steel grid carried on pillars and struts from the inner skirt of the pressure vessel. Differential expansion between the moderator and its support will be accommodated by a series of ball thrust races.

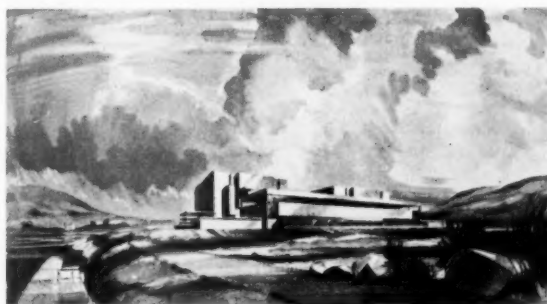
The entire moderator structure will be contained in a spherical steel pressure vessel 61 ft internal diameter, fabricated from plate $3\frac{1}{2}$ in. thick. A circumferential gas seal will be fitted between the pressure vessel and the graphite structure.

Heat will be removed from the reactor by carbon dioxide gas at a nominal pressure of 240 psig. Six boilers will be connected to each reactor pressure vessel by ducts 5 ft 6 in. dia. These ducts will incorporate expansion bellows and isolating valves.

The six boilers provided for each reactor will be in line in two groups of three, on opposite sides of the pressure vessel. The boiler shells will be 18 ft internal diameter and 116 ft high and fabricated from $2\frac{1}{2}$ in. thick steel boiler plate. A dual pressure steam cycle has been adopted for the station, the boilers generating 65% of the steam at the high pressure. Each boiler shell will contain six sets of tube banks, namely, mixed economiser, L.P. evaporator, H.P. economiser, H.P. evaporator, L.P. superheater and H.P. superheater. All tubes throughout the boiler will have external resistance welded fins to improve the heat transfer between the gas and the steam.

One gas circulator will be connected to each boiler and located vertically below the boiler. Each circulator will be a single-stage, axial-flow fan, designed to return the CO_2 to the reactor. The power consumed by each circulator will be about 6,000 hp.

A feature of the station will be the constant speed circulator drive consisting of an induction motor running



An impression of Trawsfynydd Nuclear Power Station by Mr. Basil Spence, consultant architect to Nuclear Civil Constructors, showing it in relation to the landscape of Snowdonia. Situated on the north shore of Lake Trawsfynydd (seen on the left), its buildings are grouped low so that they will not break above the skyline of Craig Gylfynys (right)

at 2,950 rpm directly coupled to the circulators. During operation the gas flow will be regulated by linked throttle valves in the main gas ducts and by-pass valves in recirculation ducts.

The reactor building will contain the reactor and the boilers, and occupy an area of approximately 300 ft by 180 ft at ground level and be 179 ft high. Each boiler, with its associated gas ducts, will be individually shielded along its entire length by walls which connect with the biological shield of the reactor itself. At boiler plinth level the building will be extended to form a common circulator house containing the electric motors for the gas circulators.

The charge machines to be provided are designed to handle fuel whilst the reactor is on load. Each machine will be a composite unit capable of carrying out all operations connected with the fuel handling system on the charge face. The machines will be approximately 64 ft high and weigh approximately 380 tons each.

Remote and local control will be provided for charge machine operations but normal operation will be from a remote control room near the charge face.

The control of the station during normal operation will be carried out from a central control room which is situated between the two reactor buildings. There will be two automatic control loops external to the reactor; one primarily intended to eliminate instabilities in the reactor neutron flux, the other for adjusting the reactor output to meet the load demand. Provision will be made for full automatic control of the station if required.

Safety of the plant has been the principal criterion of design, and all possible safety measures will be incorporated including special emergency shut-down devices.

The turbo-generators will be arranged transversely in a turbine house approximately 450 ft long and 220 ft wide. Each generator will have a maximum continuous rating of 145 MW and be a four-cylinder machine

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designed for a dual pressure steam cycle. The steam will be discharged from each turbine through six exhausts into twin condensers. The generators will have water-cooled stator windings.

The steam conditions at the turbine stop valve will be as follows: H.P. steam, 927 psig 715°F; L.P. steam, 290 psig 685°F; steam flow ratio, 65% H.P., 35% L.P.

The output from the generators will be fed to transformers to step up the voltage to 275 kV. The rating of these transformers is 157 MVA. Cables will connect these transformers to the Central Electricity Generating Board switching compound some 300 ft away. The net output of 500 MW will thus be fed into the Central Electricity Generating Board super grid system.

Auxiliary transformers will provide a supply at 11 kV and 415 V for distribution and consumption within the power station. Diesel alternator sets and batteries will ensure the continuity of supply to auxiliary plant and control equipment.

Site layout has been made as compact as possible and comprises three main areas, the reactor building area, the fuel disposal area and the turbine house area. The site is partially encircled by a main access road and thus buildings which require a service from the public highway have been located near this access road so that vehicles do not need to enter the reactor building or fuel disposal areas.

The power station is to be built on a hilly site some six hundred feet above sea level. The largest buildings of the site will be the two reactor buildings and the turbine house.

The circulating water pump house will contain six pumps capable of circulating half a million gallons of water per minute. This water will be used to cool the condensers associated with the turbo-generators. Water will be drawn from Trawsfynydd Lake and returned to the lake for natural cooling.

The first stage of the contract will involve nearly half a million cubic yards of excavation, a large amount of this being rock which will involve blasting. A labour camp near the site will accommodate about a thousand men.

Site workshops will be provided to complete the fabrication of the reactor pressure vessel and boiler shells. To facilitate speed of erection, a Goliath crane, which has a span of 250 ft and a lifting height of 200 ft, will be used to lift loads up to four hundred tons weight.

Work on the site has commenced and the completed station will be fully operational in five years' time.

The site is within the North Wales National Park and therefore the most careful consideration has been given to the design of the buildings to ensure that they will blend with their surroundings and will not break above the outline of the landscape to any large extent. Mr. Basil Spence, O.B.E., A.R.A., President of the Royal Institute of British Architects, is the architectural consultant for the project.

Atomic Power Constructions Limited was formed at the end of 1956 and comprises four companies in the field of power generation and precision engineering: Crompton Parkinson Limited, Fairey Aviation Limited, International Combustion (Holdings) Limited, Richardsons Westgarth & Co. Limited, in association with Nuclear Civil Constructors.

This last firm is a partnership of Trollope & Colls Limited and Holland & Hannen and Cubitts Limited, and constitutes the civil engineering organization which was formed to design and construct all civil engineering

and building work, and operates exclusively for Atomic Power Constructions Limited.

Atomic Power Constructions Limited is responsible for the overall conception of the project, for the design, supply, inspection, erection and commissioning of the complete power station.

The Research and Development Laboratories of Atomic Power Constructions Limited are at Heston, Middlesex, where there are extensive facilities for experimental work on metallurgical, engineering and physics problems.

The main allocation of work for the contract is as follows:

Crompton Parkinson Limited.—275 kV generator transformers; station, unit and auxiliary transformers; 11 kV, 750-MVA switchgear; 415 V switchgear; switchgear control panels; auxiliary motors and alternators; cables; lighting equipment.

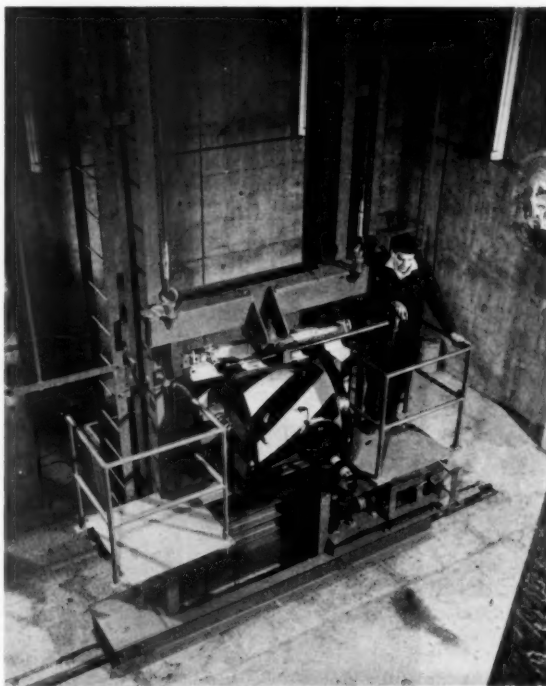
Fairey Aviation Limited.—Reactor equipment including charge machines, control rod mechanisms, graphite machining and laying, irradiated fuel disposal equipment.

International Combustion (Holdings) Limited.—Twelve boilers, each of 150 MW heat rating; main and recirculation CO₂ gas ducting; biological shield cooling system.

Richardsons Westgarth & Co. Limited.—145 MW turbo-alternator sets; condensers and feed heating plant; dump condensing plant; CO₂ gas circulators and associated plant.

Nuclear Civil Constructors.—Civil engineering work.

Babcock & Wilcox Limited (a sub-contractor).—Two spherical reactor pressure vessels each 61 ft dia, and 400-ton Goliath crane.



COBALT CONTAINER FOR INDUSTRIAL RADIOGRAPHY.—This view in the Darlington factory of Whessoe Limited shows the cobalt container of the radiographic equipment supplied by Metropolitan-Vickers Electrical Company Limited. The equipment is seen set up for the radiographic examination of 4-in thick welded plates which Whessoe Limited are supplying for a nuclear reactor vessel for Italy.

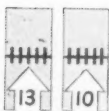
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Nylon yarns are far tougher, yet more slender than cotton yarns. Gaflex Belts are thinner, more supple—have 10 times more flexing life.



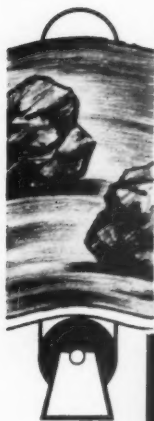
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Gaflex Nylon Weft Belting is woven in weights which correspond broadly to the conventional duck weights of 28, 32, 36 and 42 oz. and will normally contain *one ply less*. Made in three types—Gaflex Standard, Super and Plus—each designed for specific grades of materials. There is a Gaflex Conveyor Belt to suit *your* particular conveying requirements.

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Machine Tools for Engineers. By Charles R. Hine. New York, 1959; McGraw-Hill Book Company Inc. London; McGraw-Hill Publishing Company Limited. 60/- net (by post 61/9). 445 pp. 6 × 9 in.

When a book is written for people not primarily connected with its subject matter then it is usual to indicate this fact in the title. If this book had been called simply "Machine Tools" one might have expected it to be a book for engineers, so that emphasis hardly seems necessary. The author does not himself explain his purpose, but we suspect he has one nevertheless, for he is at pains to comment on at least one discrepancy between the arrangement of the education of engineers and the actual circumstances of their subsequent employment—they learn a lot about power plant and then most of them work ever after with productive machinery. Well might this majority cry "Machine Tools for Engineers!" and the author throw in the exclamation mark.

The book is an introductory work concerned more to show how the different kinds of machine tools work and what they can do than with how to operate them. All the general run of machines are covered systematically in their principal parts, their types, how the work is held, what operations are performed, what attachments are used, and what special procedures are available. Typical speeds and feeds and similar relevant data are given in each case. The book is well illustrated.

Machine Tool Operation, Part 1. By Henry D. Burghardt, Aaron Axelrod and James Anderson. New York, 1959; McGraw-Hill Book Company Inc. London; McGraw-Hill Publishing Company Limited. 45/- net (by post 46/4). 588 pp. 5½ × 8 in.

This well-known American text appeared in three editions with the name of the first mentioned of the authors: this fourth edition is the work of the other two. It is an introductory work to the fundamentals of machine tool operation, introducing where required the scientific and mathematical principles required for practical work. Most of the chapters offer studies of particular operations; others are more for reference. The book is well illustrated and the text contains many groups of rules, hints and instructions which are apposite

to the carrying out of particular manual or machine operations. The first volume deals with bench work, the drilling machine, the lathe and forging, as well as having chapters on safety and measuring tools. The second volume will deal with the shaper, the planer, the milling machine, the grinding machine, the band saw, and will also have chapters on hydraulics, metallurgy, and cutting fluids. The authors all are or have been actively connected with imparting instruction in the subject over many years and the book evidently arises out of this work and is therefore eminently suitable for use in training workshops.

books

Introduction to Stress Analysis. By Charles O. Harris. New York, 1959; The Macmillan Company. 52/6 net (by post in U.K. 53/8). 330 pp. 6 × 9¼ in.

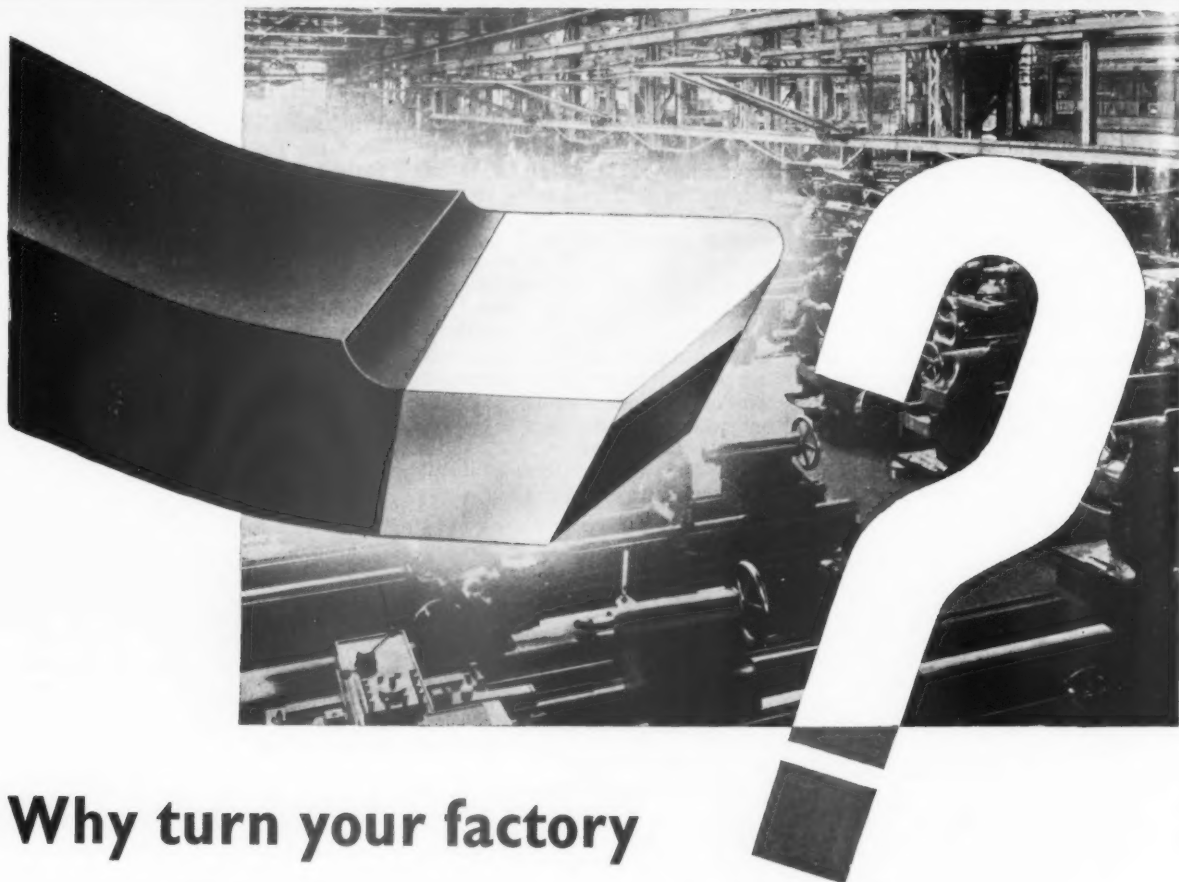
"Strength of Materials" as an engineering subject has a history without doubt, but without going into that there is no difficulty whatever in agreeing with the author of this book that, as the subject is taught today, it is in fact stress analysis with just enough about the properties of materials to get the theory along. So "Strength of Materials" goes out and we now have "Properties of Materials" and "Stress Analysis"—two clearly recognizable subjects. The treatment is theoretical, which is good for analytical thinking in these days when engineering is becoming more scientific and mathematical, and makes extensive use of the methods of synthesis and superpositions. From an introduction via the stress resultant in bars the text goes on to stress and strain, uniform stress, and then to torsion, flexural stress and deformation and the stresses due to transverse forces on bars. Then follow shear and moment diagrams, buckling phenomena, and the superposition of stress patterns. At this point the author discusses factors which affect the strength and deformation of materials before introducing some simple problems in plates and shells. Strain energy and Castigliano's theorem are then treated after which the author deals with two-dimensional axially symmetrical stress distribution in a solid of revolution,

and plasticity. The book concludes with appendices on the properties of an area, the moment-area method for elastic curve of a beam, some elements of the theory of elasticity, energy of distortion, the SR-4 electric resistance strain gauges, and modern notions of dry friction. Very useful with a treatment of this sort is the full supply of problems (there are also fully worked illustrative examples) with answers, with which the reader can test his appreciation of the text.

Engineering Drawing with Worked Examples—Vol. 2.—By F. Pickup and M. A. Parker. London, 1959; Hutchinson & Co. (Publishers) Limited. 21/- net (by post 21/11). 5¾ × 9 in.

In learning drawing one is concerned with the pencil and the drawing much more than with words, and since the object is to become proficient in the language of the drawing it is good practice to learn by using that language. This is how the authors of this book teach their subject, and their book has a maximum of drawings and a minimum of words. This is the second volume and it deals with auxiliary projection, interpenetration of surfaces, conic sections, development, cones, involute gears, riveted joints, and concludes with a number of examples of machine drawings of actual components. The book covers the syllabus in engineering drawing of the second year of the Ordinary National Certificate course.

New First Aid Box Requirements.—Changes in the contents of first aid boxes or cupboards in factories, and in the advice given on first-aid treatment are provided under a new order which will come into operation on January 1, 1960. It is the "First Aid Boxes in Factories Order, 1959" (H.M.S.O., price 3d.), and issued simultaneously is a new leaflet (H.M.S.O., price 2d.) which the order prescribes shall be included in every first aid box, giving advice on first aid treatment. The order specifies the minimum contents for first aid boxes or cupboards in three categories of factory—those employing 10 persons or less, those employing more than 10 but not more than 50, and those employing more than 50. The same range of equipment is now to be included in each box, but the quantities vary according to the number of persons employed.



Why turn your factory into an experimental shop

Why go to the trouble of forging, heat treating and grinding your cutting tools from bar stock; why waste expensive high speed steel with faulty heat treatment, or by using an expensive steel for the shank? Why not simply order Stag Major Superweld tools ready to use the minute they're unpacked—all experimenting on Superweld tools was over and done with 25 years ago, and recently a new factory was put down to cope with, the ever-rising demand. Write for further information, using the request form.

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SUPERWELD
TOOLS



To Edgar Allen & Co. Ltd., Sheffield, 9.
Please send "Stag Major Superweld" booklet and
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EDGAR ALLEN & CO. LIMITED
IMPERIAL STEEL WORKS · SHEFFIELD 9

TELEPHONE: SHEFFIELD 41054

TELEGRAMS: ALLEN, SHEFFIELD 9

BUSINESS & PROFESSIONAL

Personal

THE ROYAL SOCIETY announce that **Mr. D. J. Tritton, B.A.**, now working at the Cavendish Laboratory, Cambridge, has been appointed Rutherford Scholar for 1959 for three years, to investigate the relationship between the manner of production of turbulence in a fluid flow and the large eddy structure of that turbulence, at the department of aeronautical engineering, Indian Institute of Science, Bangalore.

THE COUNCIL OF INDUSTRIAL DESIGN announces the appointment of **Mr. J. Noel White** to be deputy director as from January 1, 1960, when **Mr. Paul Reilly**, the present deputy, succeeds **Sir Gordon Russell** as director of the council.

VICKERS LIMITED announces that **Sir Leslie Rowan, K.C.B., C.V.O.**, who joined the board in December, 1958, has now, with effect from July 1, 1959, been appointed director of finance of Vickers Limited. **Sir Leslie** has also been appointed a director of Vickers-Armstrongs Limited and Robert Bobby Limited. **Sir James Reid Young, C.A., F.C.I.S.**, having reached normal retirement age, has vacated his seat on the board of directors of Vickers Limited and **Mr. W. D. Opher, M.I.Mech.E.**, a director, of Vickers-Armstrongs Limited and of certain other group companies, and managing director of Vickers-Armstrongs (Engineers) Limited, has been appointed an additional director with effect from June 2, 1959.

THE INDIAN STEELWORKS CONSTRUCTION Company Limited (ISCON) announce the resignation of **Brigadier M. H. Cox** from the post of resident director at Durgapur as from August 10, 1959. He is succeeded by **Mr. D. J. Bell**, formerly general manager, ISCON, Durgapur Steel Project.

THE UNITED STEEL COMPANIES LIMITED research and development department announce that **Dr. K. J. Irvine** became deputy research manager on July 1, when he relinquished his duties as head of the metallurgy section, which is to be reconstituted. On the same date, **Mr. J. D. Murray** became head of the new section of applied metallurgy, which embraces high temperature metals, alloy development and welding. **Mr. F. B. Pickering** is head of another new section on physical metallurgy, which will deal with the more fundamental aspects of this subject. Appleby-Frodingham Steel Company, a branch of The United Steel Companies Limited, announce that **Mr. A. Howard** has been appointed assistant to **Dr. L. Reeve**, chief metallurgist, with the

title of research manager. **Mr. E. E. Clark** has been appointed works metallurgist and will be responsible directly to **Dr. Reeve** for all metallurgical services at the Appleby-Frodingham works. **Mr. P. A. Dixon** has relinquished his position as steelworks engineer, due to ill health, but will continue to undertake special duties with the chief engineer. **Mr. E. A. Atkin**, acting steelworks engineer, is appointed assistant chief engineer, with particular responsibility for plant maintenance and new installations. **Mr. D. R. M. Nisbet**, deputy chief electrical engineer, succeeds **Mr. W. E. Smith** as chief electrical engineer on the latter's retirement. **Mr. R. B. Atkin**, senior civil engineer, is appointed steelworks engineer. He is succeeded as senior civil engineer by **Mr. L. J. Sutherland**. **Mr. D. Singleton** is confirmed in his appointment as plant engineer (Appleby steelworks). **STEEL, PEECH AND TOZER**, Rotherham, a branch of The United Steel Companies, Limited, announce that **Mr. V. Watkins** retired as chief engineer on June 30, and is succeeded by **Mr. F. Moore**. Following the retirement of **Mr. A. G. Snape** on June 30, **Dr. B. B. Hundy** becomes chief research metallurgist. **Mr. Snape** remains with the company for a further twelve months in an advisory capacity. **Mr. D. Manterfield** retired as chief chemist at the end of June, and also continues to be available for twelve months in an advisory capacity. **Mr. P. B. Dunnill** succeeds **Mr. Manterfield** as chief chemist. **Mr. P. Holmes** retired on June 30, and is succeeded as civil defence officer by **Mr. F. R. Robinson**. **Mr. J. B. Jarvis** retired on July 31 and his successor as Ickles planning and progress manager is **Mr. W. Bates**.

Mr. P. T. Butler, previously a buyer with Coldair Limited, and **Mr. N. E. Griffiths**, previously with British Paints Limited, have been appointed sales representatives with Anti-Dust Services Limited, of Dudley, Worcs. **Mr. Butler** will cover the South London and South-East England area, and **Mr. Griffiths** the North of England and Scotland.

ON reaching retirement age **Mr. Ernest Crosse** relinquished his position as an executive director of **J. Brockhouse & Company Limited** on June 30, 1959.

BILL SWITCHGEAR announce the appointment of **Mr. G. H. Garbett** to the board of directors with effect from April 21, 1959. **Mr. Garbett** joined the company in 1939 as North Midlands area engineer.

Two appointments are announced by **Waymouth Gauges and Instruments of Godalming**, one of the group of companies

in the Smiths Aviation Division. They are **Mr. H. W. Davis**, chief technical executive and **Mr. I. B. Johnson**, chief designer.

METAL INDUSTRIES LIMITED announces that **Mr. W. Padley, C.M.G., O.B.E.**, who has been personal assistant to the chairman, **Sir Charles Westlake**, has been appointed administrative controller. **Mr. P. Jardine**, the group chief accountant, becomes group financial controller.

CROMPTON PARKINSON LIMITED announce that **Mr. B. A. Christie** has joined I.T.D. Limited and took up the appointment of managing director of that company on June 17, 1959. On the same date the following executive officers of the company will be appointed associate directors: **Mr. L. A. Rochefort**, general manager; **Mr. A. C. Cooper**, general sales manager; and **Mr. R. J. Stokes**, secretary; I.T.D. Limited of Hall Green, Birmingham, are manufacturers of fork-lift trucks and other materials handling equipment. The company is owned equally by the Austin Motor Company Limited, Crompton Parkinson Limited and Clark Equipment International, C.A. of U.S.A.

Mr. C. A. B. Malden has been appointed joint managing director, with **Mr. J. G. Cronk**, of Amber Oils Limited.

Miss F. M. Buckley, sales director of **F. Pratt and Company Limited** of Halifax, has been appointed to the board of **Pratt Precision Hydraulics Limited**, the company dealing with specialist hydraulic development within the Pratt group.

Mr. B. Pringle, manager of The British Thomson-Houston Company Limited, motor engineering department, Rugby, was made a Member of the British Empire (M.B.E.) in H.M. The Queen's Birthday Honours.

Mr. Arthur Richardson, sales manager of the David Brown Industrial Gear Divisions since 1953, has been appointed commercial manager of the company's automobile gear divisions. **Mr. Richardson** joined the David Brown Gear Group 45 years ago.

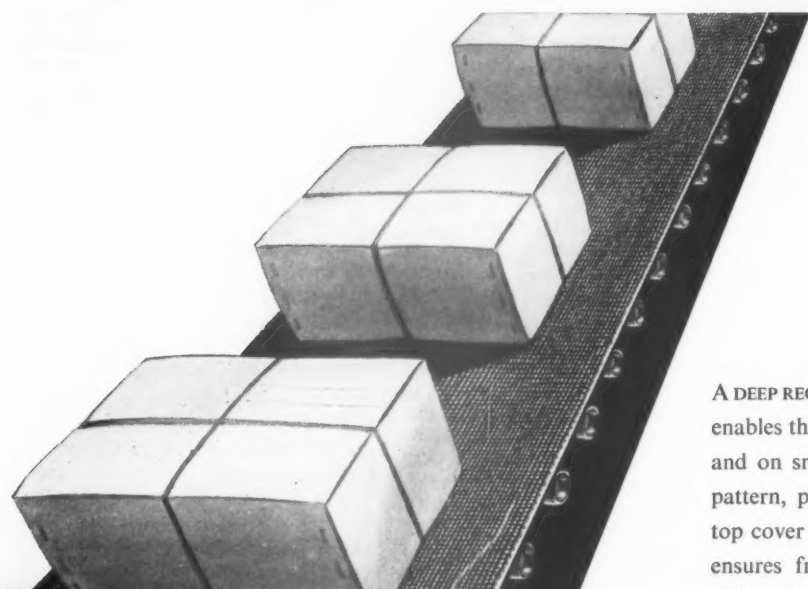
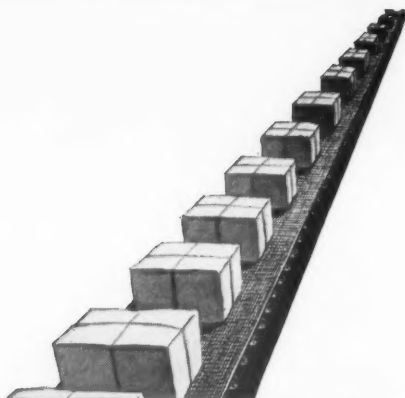
Mr. G. T. P. Gardner has been appointed sales director of **B.M.B. (Sales) Limited**, Crawley, Sussex, who are the sole selling agents for British Manufactured Bearings Company Limited, John Bass Limited, and Pathfinder Limited. **Mr. Gardner** joined B.M.B. in 1949 as secretary, he subsequently became works manager and later works director.

Obituary

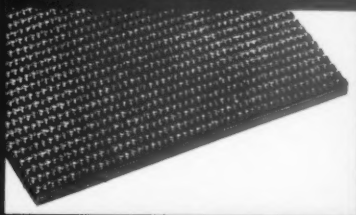
We regret to record the death in Lisbon on June 6 of **Mr. A. T. Holman**, chairman of

LIFT WITHOUT SLIP

with Goodyear rough top conveyor belting



**GOODYEAR CONVEYOR BELTING
TYPE D. ROUGH TOP**



- A. Thick top cover with deeply impressed gripping pattern.
- B. Carcass of 28 or 32 oz. high quality cotton duck.
- C. Thickness of hard wearing bottom cover or friction surface to suit service.

A DEEP REGULAR pattern, exclusive to Goodyear, enables this belting to take a firm grip on sacks and on smooth articles, such as cartons. The pattern, plus a choice between soft and hard top cover to suit the needs of the installation, ensures freedom from slip on slopes up to 30° inclination.

Goodyear Rough Top belting, like all styles of conveyor belting in the Goodyear range, is solely designed for a specific type of duty, and to give long, reliable service at lowest cost per ton carried.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS

CONVEYOR BELTING • TRANSMISSION BELTING • HOSE • V-BELTS

BUSINESS & PROFESSIONAL

Holman Brothers Limited, Camborne. Mr. Holman was attending the British Trade Fair while recuperating in Portugal after an illness.

WE regret to record the death in Paris of Mr. L. K. Everitt, a director of Edgar Allen & Company Limited, and general manager of the steel department, while on a visit in June last to their subsidiary company, Acieries d'Hirson.

Addresses

A NEW company has been formed in Italy by Ekco Electronics Limited, to be known as Ekco Nucleare Italiana, s.r.l. The managing director is Ing. Silvio Garrone and the head office is at Via Dei Malvezzi, Rome, and a further office at Corso Matteotti 2, Milan.

LIGHT SOLDERING DEVELOPMENTS LIMITED are now established in their new premises at 28 Sydenham Road, Croydon, Surrey. Telephone number as before, Croydon 8589.

THE new address of Smiths Aviation Division is Kelvin House, Wembley Park Drive, Wembley, Middlesex. Telephone WEMbley 888. Telegrams Airspeed, Telex, Wembley.

NEW offices in Birmingham have been opened by A. I. Electric Welding Machines Limited, at Grove House, Sutton New Road, Birmingham 23. Telephone Erdington 1176. The company's London address has been changed to Temple Chambers, Temple Avenue, London EC4. Telephone FLEet Street 6660.

MATTHEWS & YATES LIMITED, manufacturers of Cyclone fans and equipment, have transferred their Birmingham office to larger premises at Smithfield House, Digbeth, Birmingham 5. Telephone Midland 7284 (2 lines).

THE telephone number of Claude Lyons Limited of Valley Works, Hoddesdon, Herts, has been changed to HODdesdon 4541-4.

THE Lincoln branch office address of British Insulated Callender's Cables Limited has been changed to Holmes Road, Lincoln. Telephone number as before, Lincoln 21351. The telephone number of BICC "Panelec" Heating Division—formerly "Panelec" (Great Britain) Limited—is now Museum 1600.

CAUSEWAY REINFORCEMENT LIMITED, a member of the Amber group of companies, has new premises in Kent at Five Ash Works, Dover Road East, Northfleet. Telephone number Gravesend 6222. The company retains its London office at 11A Albermarle Street, W1.

THE METAL INDUSTRIES GROUP has set up another company in Europe—Fawcett Preston (Europe) S.A., formed to handle



WORKS NEW RECEPTION ROOM.—The new reception room shown here is at the Attercliffe Steel Works of Sanderson Brothers and Newbould Limited, Newhall Road, Sheffield 9. It was opened by Mr. Lewis Chapman, president of the British Iron and Steel Federation, on July 3 last, and is part of a new office modernization scheme

the products of Fawcett Preston at Bromborough, Cheshire, with headquarters at 6 Square de L'Opera, Paris, 9e.

Long Service Awards— The Hoffmann Scheme

THE thirteenth annual presentation of awards for long service took place on June 17th last at the Hoffmann Manufacturing Company Limited, Chelmsford, manufacturers of ball and roller bearings. Mr. J. W. Garton, J.P., chairman and managing director of the company, presented gifts chosen by the recipients to 43 men who had completed 40 years' service and 4 women who had completed 35 years' service. Since the long service recognition scheme was introduced in 1947, 449 men and 42 women have qualified. Under the scheme the company also makes cash awards paid each year upon an increasing scale to employees completing 10, 20, 30 and 40 years' service. Additional holidays of one and two weeks are also granted to 30 and 40 years' service employees.

Business Developments

Trading agreements

A MANUFACTURING agreement between The Goodyear Tyre and Rubber Company (Gt. Britain) Limited and Electro Hydraulics Limited provides for the production by Electro Hydraulics of all Goodyear designed wheel, brake, and associated hydraulic equipment formerly produced at Wallasey. Goodyear retains responsibility for design, modification and repair of all equipment except hydraulic brake controls which will be designed and manufactured by Electro Hydraulics. Aero

tyre production is not affected by the agreement and will continue at Goodyear Wolverhampton factory. Facilities at Wolverhampton and Hounslow are being expanded.

By joint agreement between the General Electric Company Limited and Wild-Barfield Electric Furnaces Limited, the latter company will carry out at their Watford works the repair and maintenance service for all G.E.C. valve operated high frequency generators.

New technical and sales agreements have been concluded by British MonoRail Limited of Brighouse, Yorks., and American MonoRail Co. (Cleveland, Ohio, U.S.A.). British MonoRail Limited can now offer a complete overhead materials handling system in conjunction with the products of Herbert Morris Limited.

Contracts and Work in Progress

BROOKHIRST IGRANIC LIMITED (METAL Industries subsidiary).—Contract value £50,000 for control gear for the Baghdad main drainage scheme, placed by the Pulsometer Engineering Company Limited, who are supplying the pumps.

FAWCETT PRESTON & COMPANY Bromborough, Cheshire.—U.S.A. order for an automatic synthetic fibre baling press, has been placed by the H. K. Ferguson Company on behalf of Fiber Industries Inc., of North Carolina. Value \$76,000.

SIGMUND PUMPS LIMITED, Gateshead.—Numerous recent overseas orders including

BIGGEST AND WIDEST RANGE EVER OF CARBIDE TIPPED DRILLS!

Pioneers in carbide tipped masonry drills, the Rawlplug Company has gone still further ahead with the widest range of percussion, vibration

and rotary drills obtainable anywhere. Whether its for hand or power use, you're bound to find the type and size you want in the Rawlplug range.

'DURIUM' TIPPED MASONRY DRILLS

So famous have these amazing drills become that the name DURIUM tends to be used for any drill of its general type. *Don't be misled by this.* DURIUM means the special New Process, almost diamond-hard, carbide tip developed and made only by the Rawlplug Company. No other drill is a genuine Durium. DURIUM Drills give really sensational cutting performances in brick, tile, cement, slate, etc. They are silent in operation and have a quite exceptional long-service capacity for withstanding the abrasive action of masonry that so quickly ruins ordinary drills. Another exclusive feature of Durium Drills is their patented rapid-helix flute, which forces out spoil and prevents clogging. Only a Durium Drill—a genuine Rawlplug Durium—gives such life and service. First resharpening is FREE!

For use in Wheelbrace or slow speed electric drill

17 sizes 5/32" to 1" cutting diameter and 11 long series 1/4" to 1" cutting diameter for up to 16" drilling length.



'DURIUM' TIPPED HAMMER DRILLS

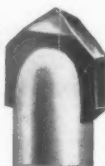


For percussion drilling in hard materials such as Granite, Blue Bricks, Concrete etc., Durium Hammer Drills have a very much longer life than ordinary percussion drills. They can be used in most electric Hammers and some type of Pneumatic Hammers. 13 sizes from 7/16" nominal drill diameter to 1 1/4".

'DURIUM' TIPPED GLASS DRILLS

For use in glass, china, vitrolite, pottery, etc. Can be used in a wheelbrace or slow speed electric drill.

9 sizes from 1/8" to 1/2" cutting diameter.



'VIBROTO' HARD TIPPED DRILLS FOR VIBRATORY DRILLING

Vibroto Drills are specially manufactured for use with the Vibroto Drilling Machine, —a high efficiency power tool which allows of two vibratory actions (Light Rapid and Heavy Slow), and also a rotary action for use with standard Durium masonry Drills or ordinary Twist Drills. With their special cutting angle metallic carbide tips, and the high grade steel shanks heat-treated to withstand abrasion, Vibroto Drills put up spectacular performances in the drilling of concrete and other hard materials. Demonstrations can be carried out by Rawlplug Technical Representatives anywhere in the British Isles.

10 sizes 5/32" up to 15/32" cutting diameter.



'RAWLCRETE' TUNGSTEN CARBIDE TIPPED (ROTARY) CONCRETE DRILLS

These drill are designed for hole boring in concrete, hard brickwork and tiles with portable rotary action tools. They have from four to six cutting edges (depending on size) and if one should be damaged the remainder will go on cutting. Spoil is automatically carried away through the cored shank and ejected via the slot.

EXTENSION TYPE DRILLS ANY DEPTH

By adding extension rods to the Extension Type Rawlcrete Drill, any depth of hole can be drilled.

26 sizes 1/8" up to 2" cutting diameter.



RAWLPLUG FIXING DEVICES AND TOOLS FOR SPEED AND RELIABILITY

WRITE NOW
for illustrated literature
describing fully these and
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performance drills and
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BUSINESS & PROFESSIONAL

refinery pumps for South Africa, municipal water works units for Mozambique, pumps for various applications in the Philippines, irrigation equipment for Iran and 46 large pumping sets for Soviet Russia, the last being part of a £1½m. contract for a beet sugar factory negotiated by Bookers Engineering Holdings Limited, of which Sigmund Pumps is a group member.

LEO COMPUTERS LIMITED.—Supply of a Leo II Automatic Office for British Oxygen Gases Limited at Edmonton works.

WORTHINGTON-SIMPSON LIMITED, Newark.—Order from C.E.G.B. for the supply of a complete condensing and feed heating plant for one 120 MW turbo-alternator at Bankside B power station, London.

ELECTRO-CHEMICAL ENGINEERING COMPANY Limited, Woking (subsidiary of Efco

Limited).—Order from Japan for the supply of an electro-metallurgical plant. Contract price over £300,000.

WILD-BARFIELD ELECTRIC FURNACES Limited, Watford.—Orders from France and Belgium including a complete heat-treatment installation for the hardening steam tempering, etc., of a variety of watch parts, and for Fabrications Automonile Belges of Antwerp, a further gas carburizing equipment of the vertical pit type.

Order for a Wild-Barfield NRC induction heated vacuum melting furnace for The Mond Nickel Company Limited.

BAKER PERKINS LIMITED, Hebburn-on-Tyne. Order from Federated Foundries for a Taccone diaphragm moulding machine

value £27,000, capable of squeezing simultaneously two moulding boxes 84×36×12 in. deep. Squeeze time for one complete mould 1.5 sec. Believed to be the largest sand-moulding machine in the world.

BAIRD & TATLOCK (LONDON) LIMITED.—Appointed contractors for the supply of all laboratory apparatus, chemicals and equipment for the laboratories of the Durgapur Steelworks, now being built in India by The Indian Steelworks Construction Company Limited, (ISCON), a consortium of 13 British companies.

DAVID BROWN INDUSTRIES LIMITED.—Order for Centurion tank gearboxes worth £110,000 for the Ministry of Supply.

FERRANTI LIMITED.—Order from Bruce Peebles & Company Limited for a £60,000 Pegasus digital computer.

Electrolytic Conductivity Measuring Bridge

The newly issued second edition of leaflet MCI, describes and illustrates the Mark III portable, electrolytic conductivity measuring bridge made by Electronic Switchgear (London) Limited, Works Road, Letchworth, Herts. The instrument embodies a number of improvements of interest to water purification engineers and to chief chemists and engineers concerned with the instrumentation of steam raising plant. The new bridge is provided with a finely divided, silvered measuring dial which is indexed by a hairline Perspex cursor which enables measurements to be read with accuracy; a printed ivory instruction panel now appears on the inside of the detachable hardwood cover of the case, and a shoulder strap has been provided. The small dry battery which energizes the transistorized circuits, is now contained beneath a detachable cover within the accessory compartment so that the battery can be renewed without removing the instrument panel.

5-ton Conveyor Ball Unit

A conveyor ball unit of 5 tons capacity has been added to the Omni-track range described in our issue of September last. A new leaflet from the makers, Autoset (Production) Limited, Stour Street, Birmingham 18, gives particulars of the full range from 5 lb to 5 tons capacities. The new model has a 2 in. dia ball with the addition of a spring loaded scale excluder.

New Alcon Pump

The Alcon 1½ in. pump made by Arthur Lyon & Co. (Engineers) Limited, 6 Carlos Place, Grosvenor Square, London W1, has been completely redesigned and now has greatly increased capacity with less total weight. It is available with Jap/Vill engine (ask for Leaflet No. 137) or American Briggs & Stratton or Clinton engines (Leaflet No. 136): 4800 gph with the former and 4600 with the latter.

Trade Literature

Magnetic Separators

"Rapid" patented permanent magnet pulleys and separators are the subject of Publication 121/R now available from Rapid Magnetic Machines Limited, Lombard Street, Birmingham 12. Full tabular data of sizes and capacities are given together with technical notes and examples of applications.

Electronic Amplifiers

The Kent range of high sensitivity amplifiers is specially designed for applications in measurement and control. They have a high gain and improved signal-to-amplifier noise ratio. The various types available are described in Publication 355A obtainable on request from George Kent Limited, Luton, Bedfordshire.

Kent Spare Parts List

When George Kent Limited take an instrument off their selling list they maintain a full supply of spare parts for ten years from the date of the last sale. Anyone who has the R.L. level recorder, therefore, should get Publication 1009, which lists and illustrates spare parts for the instrument, from the company's works at Luton, Bedfordshire.

Continuous Cast Bronze

The Encon continuous casting plant at Enfield Rolling Mills Limited, Brimsdown, Enfield, Middlesex, has been in operation for two-and-a-half years and its products are finding increasing applications in the engineering industry. The plant produces continuous cast rods, tubes and shapes in phosphor bronze, leaded phosphor bronze, gunmetal and leaded gunmetal. A new catalogue now available from the company shows the great variety of sections which can be made. It is clear that by having rod made in this way it is often possible to make intricate components simply by parting

them off the bar. The catalogue gives useful data on material properties and weights.

Secoflex

A leaflet from Secomastic Limited, Western Road, Bracknell, Berkshire, describes a new expansion joint sealant named "Secoflex". It is a permanently plastic and waterproof bituminous compound for sealing wide joints, cracks and cavities in concrete, brickwork, asphalt and metal structures. It is for both new construction and permanent repair work.

Coil Cleaner

A leaflet from The Pyrene Company Limited, Great West Road, Brentford, Middlesex, describes the use of "Pyroclean No. 201", an inhibited acid based material specially formulated for the removal of heavy phosphate scale and sludge from heating coils in Parkerizing and Bonderizing tanks and similar installations. It is also useful for descaling barrels.

Lifting Magnets

Technical data regarding the "Lift-master" electric lifting magnets made by Rapid Magnetic Machines Limited, Lombard Street, Birmingham 12, are given in a new leaflet. Dimensions range from 52 in. to 72 in. dia and lifting capacities from 1½ to 2½ tons of iron or scrap.

Clarkson Drills

Clarkson (Engineers) Limited, of Nuneaton, who are well known for their milling cutters, are now selling a full range of twist drills in standard parallel and taper shanks and made from high speed steel to B.S.328/1950. All the drills are to B.S.I. tolerances. An illustrated catalogue and price list is now available.

Erratum

"Ball and Roller Bearing Catalogue".—

The paragraph on page 335 of our July issue relating to the new Ransome & Marles catalogue should have referred to magneto bearings, not magnetic bearings.

can
you
afford
to stand

still?

... are you still losing time and money by repairing screw threads in the old-fashioned way? Heli-Coil Screw Thread Repair Kits enable you to replace weak or stripped threads in minutes, at a cost almost too small to estimate!

Simply drill, tap and install a Heli-Coil Insert to produce a conventional thread many times stronger than an unprotected thread. It will outlast the rest of the part!

Although the cost of Heli-Coil Inserts is negligible, they are capable of making items serviceable when the metal is too worn to withstand ordinary screw thread repair. Years of use can now be obtained from parts that would otherwise have to be scrapped. The cost of complete replacements is saved and the inconvenience of delays. Three standard types of Heli-Coil Repair Kits are available, plus Special Purpose Kits "tailored" for particular products. Heli-Coil Inserts are made with either English, American or Metric Threads.

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screw thread
repair kits



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Please forward illustrated literature
on Heli-Coil Screw Thread Repair Kits to:

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ARMSTRONG PATENTS COMPANY LTD.

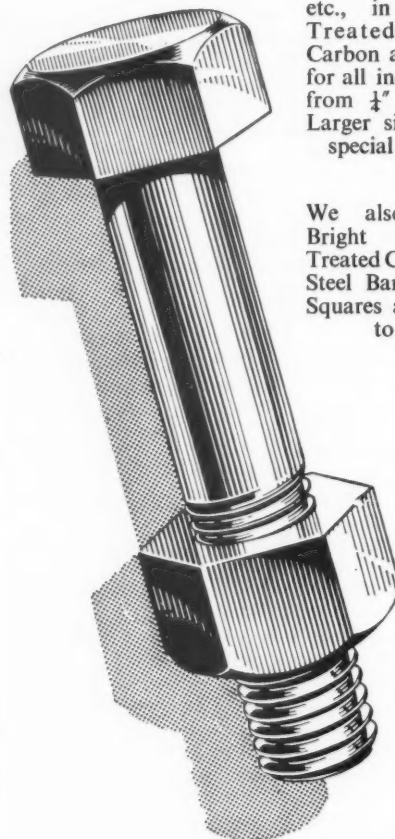
Eastgate, Beverley, Yorkshire. Tel: Beverley 82212 (6 lines)
APL 48/K 20

Marwin

BRIGHT & HIGH TENSILE

bolts

Highest quality Hexagon Head Bolts, Nuts, Studs, Sets and special parts etc., in Bright, Heat Treated High Tensile Carbon and Alloy Steels for all industries, in sizes from $\frac{1}{4}$ " up to 3" dia. Larger sizes supplied to special requirements.

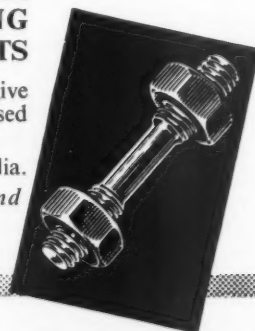


We also manufacture Bright Drawn Heat Treated Carbon and Alloy Steel Bars in Hexagons, Squares and Rounds up to $3\frac{1}{2}$ " dia.

**HIGH TEMPERATURE
CREEP RESISTING
STUD BOLTS**

Specialised products that give great resistance when exposed to high temperature.

Sizes range from $\frac{3}{8}$ " to 3" dia.
Full technical details and Catalogue on request.



W. MARTIN WINN LTD.

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Blaydon. Churchill Gear Machines Limited are planning considerable extensions to their works at Blaydon and negotiations are proceeding for the necessary land.

Darlington. J. Vickers and Son Limited, pattern-makers and toolmakers, Longfield Road, are to erect new industrial buildings covering 5000 sq. ft at Alliance Works, Darlington.

Durham. The Central Electricity Generating Board, Carlisle House, Newcastle upon Tyne, are to erect maintenance depot, etc., at Framwellgate Moor. Plans by Cordingley and McIntyre, Owengate, Durham City.

North-Eastern Trading Estates Limited. Low Fell, Gateshead. Plans for a storage building on the Dragonville Estate have been prepared by G. H. Gray and Partners, 8 Portland Terrace, Newcastle upon Tyne.

Messrs. Swinburne and Jackson, solicitors, Market Place, Durham, acting on behalf of J. Richardson and P. Gordon, have applied to the planning authorities for permission to establish a coachworks at Framwellgate Moor.

Felling. The Urban Council has accepted the tender of J. Clark and Son, Gregson Terrace, Seaham, at £16,804 for the second stage of the Abbotsford Road depot reconstruction scheme.

Gateshead. Dependable Products Limited. The contract for factory additions on Team Valley trading estate has been let to Matthews and Co. Limited, Nile Street. The architects are Newrick and Blackbell, 58 John Street, Sunderland.

Hartlepool. Arosa Hosiery Co. Limited. The architects for factory extensions (16,000 sq. ft) are Newrick and Blackbell, 58 John Street, Sunderland. R. Matthews and Co. Limited, Nile Street, Sunderland, are the contractors.

Jarrow. Castle Structures (Baldon) Limited, civil engineering contractors, 12 New Bridge Street, Newcastle upon Tyne, are to erect office block, factory and stores building at Jarrow, costing £12,000.

Northern General Transport Co. Limited. A garage and office block is proposed in Station Street. The architect is R. C. Cowmeadow, Slad, Stroud, Gloucester.

Steel & Co., mineral water manufacturers. Factory additions are being made on Bede trading estate. The builders are R. Jordan Limited, North Shields; architects, Newrick and Blackbell, 58 John Street, Sunderland.

Middlesbrough. The Tees Valley and Cleveland Water Board, Corporation Road, is to place contract this month for constructing rapid gravity filtration plant at Lartington. Plans are by the Board's Chief Engineer (T. S. R. Winter).

Bentley's Bakery. Extension plans have been prepared by Kitching and Co., 21 Albert Road, Middlesbrough.

Newcastle Hospital Board. The tender of Rowells (1924) Limited, Byron Street, Newcastle upon Tyne, at £17,646, for engineering services for the remodelling of the laundry at West Lane Hospital has been accepted.

Greco Brothers, wafer manufacturers. The architects for a proposed biscuit factory in Suffield Street are Kitching and Co., 21 Albert Road.

Tees Side Bridge and Engineering Works Limited are to extend their steel constructional and stock bay at South Bank Road.

Newcastle upon Tyne. Lion Brush Works Limited. Plans for a factory building have been approved. The architect is A. R. Forsyth, 4 Broadway West, Gosforth.

North Shields. The Federation of Indus-

trial Development Associations, 68 Fleet Street, London, E.C.4, propose to build a factory connected with food manufacturing. Premises covering 100,000 sq. ft are needed.

South Shields. Sunderland and South Shields Water Co. Limited. New offices and a depot are being built in South Shields Market Place. The contractors are R. Costain Limited, 16 Great North Road, Newcastle upon Tyne, and the architects G. T. Brown and Son, 53 Fawcett Street, Sunderland.

S.P.D. Limited. Plans have been approved for extensions to cold store and office block in Newcastle Road. The consulting engineers are Snow and Partners, Munro Buildings, Wellington Street, London, WC2.

Stockton-on-Tees. Jarman and Flint Limited, wholesale food distributors, Tyndale Street, propose building a 20,000 sq. ft warehouse on the Portrack Lane Estate.

New Factories

J. W. Henderson and Co. Limited, builders and contractors, Church Road. Planning approval has been given for office block in Church Road.

Sunderland. Austin and Pickersgill Limited are to reconstruct the dry dock at the Wear Dockyard. The present timber flooring and walls will be replaced by reinforced concrete, and new dock gates are to be built. The consulting engineers are R. T. James and Partners, Clavering Place, Newcastle upon Tyne.

H. Ibbotson. Plans for the first stage of proposed bakery in Nile Street are being prepared by Newrick and Blackbell, 58 John Street, Sunderland.

Newcastle upon Tyne Regional Hospital Board have accepted the tender of Rowells (1924) Limited, Byron Street, Newcastle upon Tyne, at £9,642, for installing engineering services for operating theatre suite and X-ray dept. at Sunderland General Hospital.

Steels Engineering Co. Limited. A two-storey office block is proposed at the Crown Works. The firm have prepared their own plans. A factory extension for the company is being carried out by Tarslag Limited, Bowesfield Lane, Stockton-on-Tees.

Tynemouth. Esso Petroleum Co. Limited, London, are to start work shortly on the construction of a deep-water berth to accommodate 26,650 ton oil tankers at a new oil terminal at Northumberland Dock. A contract for the berth will be finalized in the near future.

Washington (Co. Durham). Washington Chemical Co. Plans are under consideration for office block in Station Road. The architects are Powell Duffryn Technical Services Limited, The Side, Newcastle upon Tyne.

Whitby. Town Tailors Limited. The planning authorities have received an application to convert the Metropole Garage into a clothing factory.

Birmingham. Metpat Co. Limited, 187 Gooch Street, are to erect a new factory at Bissell Street, Highgate area.

Artis Limited. 34 Lower Loveday Street. A new factory is to be built at Summer Lane.

Blackburn. Walsh Bros. (Blackburn) Limited, Sudell Cross. The architects for the new premises on the site of Peel Mill, Montague Street, are Campbell & Driver, Richmond Terrace.

Bracknell New Town. E.M.O. Instrumentations Limited. Extensions are to be made to the works.

Bristol. Simmette Limited, 8 Sheen Road, Bedminster, to build a new factory.

Chester. G. & W. Collins Limited, 56 Vauxhall Road, Liverpool, 3. The architect for the new factory to be built at Sealand Road is R. G. Ellis, 16 Cook Street, Liverpool.

Coventry. Salt Engineering Co. (Coventry) Limited, St. John Street, are to relocate their factory on a site at Bishop Street.

Dewsbury. Newsome & Spedding Limited, Adams Road, are to make extensions to their mill.

M. Dew & Co. Limited, 686-690 Huddersfield Road. Extensions are to be made to the factory.

Falkirk. British Aluminium Co., Norfolk House, St. James's Square, London. Extensions estimated to cost £75,000 are to be made to the factory at David's Loan, Bainsford.

Farnborough. Solartron Limited, Queen's Road, Thames Ditton. Plans have been approved for the erection of a new factory at Victoria Road.

Feltham. Paper Cap Manufacturing Co. Limited are to have extensions made to their works.

Hayes. R. Woolf & Co. (Rubber) Limited, Hayes Bridge, Uxbridge Road. Works extensions.

Hereford. H. Wiggins & Co. Limited. Extensions to factory.

Kingston upon Thames. Blewis & Shaw (Plastics) Ltd., 74 London Road. The contractors for the new factory are Howard Farrow Limited, 1 Russell Parade, Golders Green, London, NW11.

Liverpool. J. Kirkham & Co., Fruit Exchange Buildings. The contractors for the new factory to be built at Flint Street are J. B. Johnson & Co. Limited, 17 Overton Street.

London. W. G. Evans & Sons Limited. Extensions are to be made to the factory at Cullen Way.

Manchester. The Co-operative Wholesale Society Limited, Balloon Street, are to build a new engineering works at Knowsley Street and Sherborne Street.

Mansfield. Landers Bread Limited, Oxford Street. Extensions are to be made to the works.

Margate. Emco Brass Co. Limited. The factory at Ramsgate Road is to be extended.

Northampton. Geisen & Wolf Limited, Victoria Road, are to build a new works on Dallington Fields.

Northern Ireland. Undare Engineering Limited are to erect a new factory at Seagoe.

Radcliffe. Strebor Diecasting Co. Limited. The architects for the new factory to be built at Allens Green are Young & Purves, The Crescent, Salford.

Redditch. William Tyers & Co. Limited, Crescent House, Mount Pleasant, are to build a new factory at Beoley Road.

St. Albans. Transplanter (Robot) Limited have received permission to make extensions to their factory at Guildford Road.

Stretford. Ingersoll Rand Co. Limited are to make extensions to their factory.

Swansea. The Viscose Development Co. Limited. The factory at South Dock is to be extended.

Thetford. G. Williams Engineering Co. Limited, Mission Hall, Disraeli Road, London, NW10. The contract for the erection of the new engineering works has been let to Tooley & Youngs Limited, Stalham.

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